The Oil Mining Company, Inc. (TomCo)

Ground Water Discharge Permit No. UGW470003

Comment Response Summary

Utah Division of Water Quality

July, 2015

I. INTRODUCTION

A. Oil Shale Mining and the Southern Uinta Basin

The Southern Uinta Basin has been a source of potential oil shale mining for decades[1] (Fig. 2). As such, the likelihood of actual commercial operation and production has cycled along with the price of oil on world markets. The Oil Mining Company, Inc. (TomCo) has submitted a ground water discharge application to the Director of the Division of Water Quality (DWQ[2]) for an approximately three-quarter size test capsule or Early Production System (EPS) (site location Fig. 2-1). While, from the basis of permitting requirements the EPS permit stands alone on its own facts and merits, relative to the potential for full scale operation and production at the TomCo site and other commercial operations currently being planned in the oil shale rich areas across the Southern Uinta Basin the permit is not alone. After reviewing the comments, DWQ is satisfied from a substantive perspective that the permit order is properly protective, based on negligible risk to ground water and its present and future beneficial uses.

B. Organization and Nature of Response to Comments

The only comments received during the public comment period were submitted by Living Rivers through Western Resource Advocates (WRA). Part I of this document presents the primary considerations in permit drafting which include: 1) Legal and regulatory requirements; 2) Natural site and regional conditions including, among others, the hydrogeology and climatic conditions; and 3) The mining and oil production operation as proposed by the applicant. Part II addresses specific comments submitted by WRA.

C. Legal and Regulatory Requirements

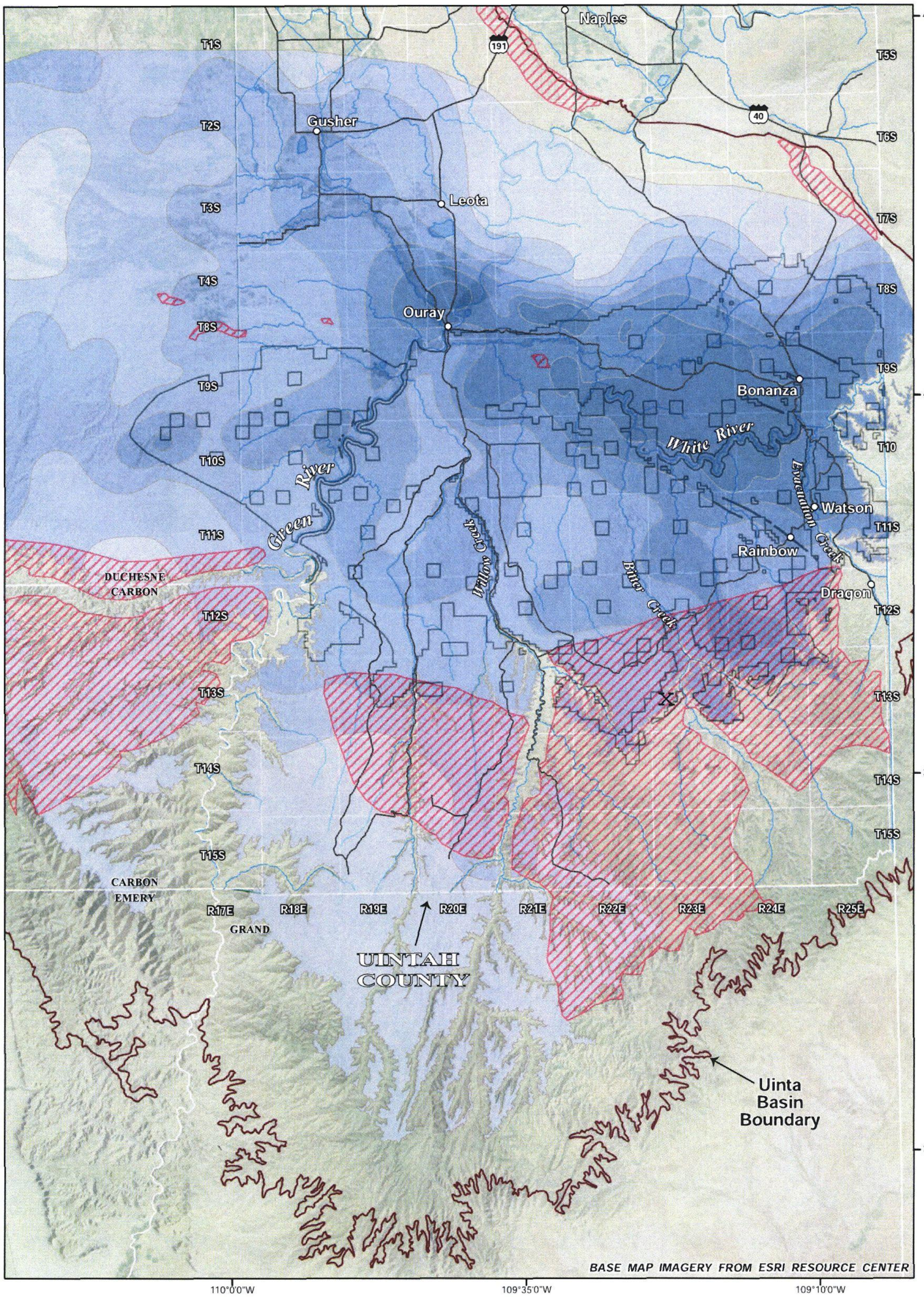
1. The DWQ under the authority of the Utah Water Quality Act and the Utah Ground Water Quality Protection Rules[3] (Ground Water Rules) issues ground water discharge permits to facilities which have a potential to discharge contaminants to ground water. As defined by the Ground Water Rules, such facilities include mining operations.[4] The purpose of the Ground Water Rules is to provide for the, maintenance and protection of current and probable future beneficial uses of ground water without ruling out man's economic, social or recreational activities. Ground

[1] Note that Figure 2 shows the basin wide extent of the naturally occurring oil shale and sands as well as the thickness of the richest [gallons per ton] oil shale across the basin, the thickness of lower yielding, uneconomic, oil shale is much greater)

[2] For convenience, the term DWQ refers to both the Division of Water Quality and its director.

[3] Utah Admin. Code R317-6

[4] Utah Admin Code R317-6-6.1A



Explanation

- Water course
- Road
- Town/city/settlement
- Water bodies
- Lands determined by the U.S. Bureau of Land Management as having oil shale development potential (U.S. BLM PEIS, 2012)
- Oil sand deposit
- X Approximate location of mine

Thickness of the 25 gallon per ton oil shale*

- >0-5 ft
- 5-20 ft
- 20-40 ft
- 40-80 ft
- 60-80 ft
- 80-100 ft
- 100-130 ft

*from Vanden Berg (2008)

0 2 4 8 12 16 Miles

N

UTAH

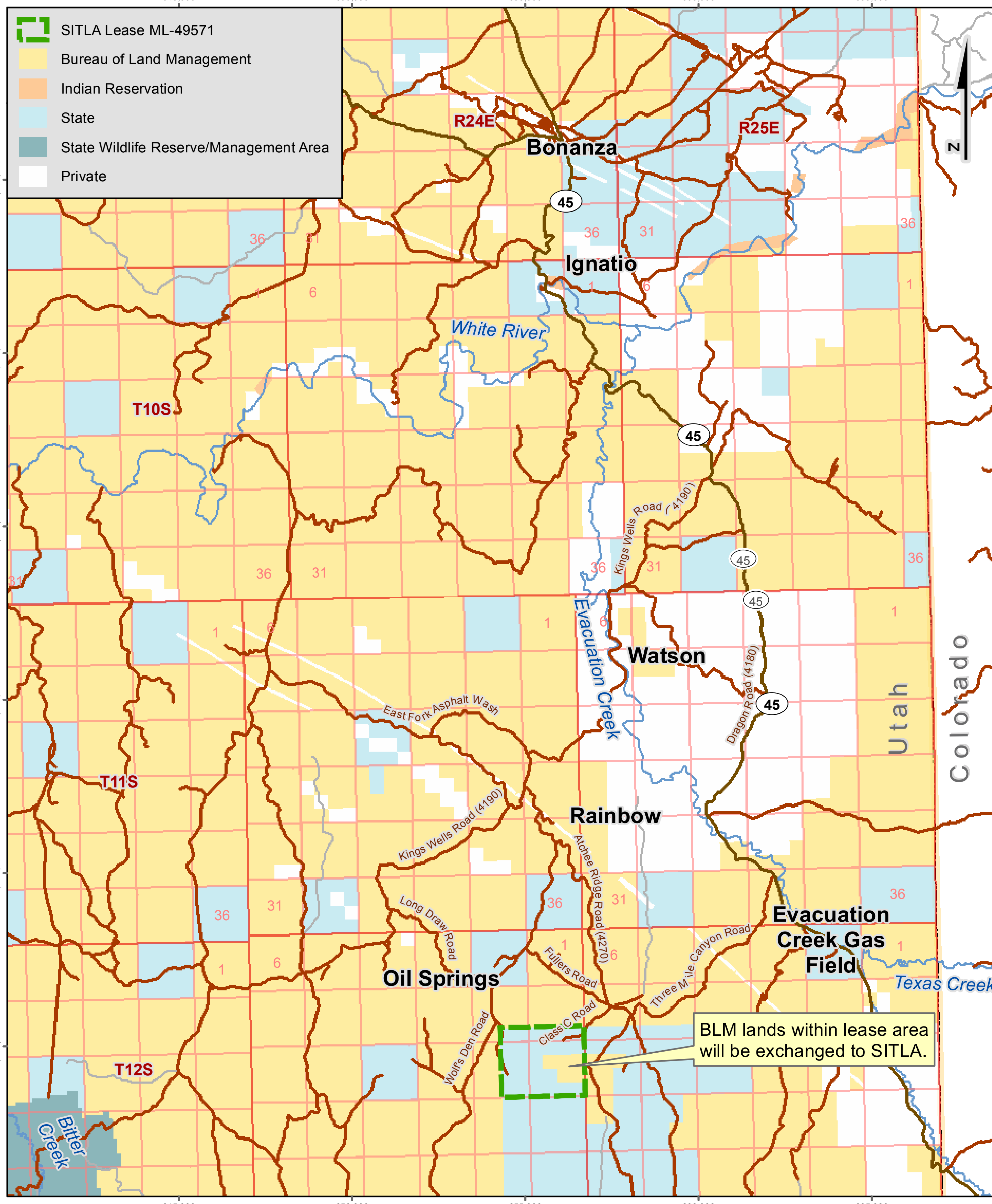
Uinta Basin Boundary

Study Area

Location Map

Figure 2. Oil shale and oil sand deposits in the eastern Uinta Basin.

Adapted from UGS open file report 595



NAD 1983 UTM Zone 12N

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Figure 2-1
Location Map
The Oil Mining Company, Inc.
Uintah County, Utah

water is divided into classes based on its quality[5]; and higher-quality ground water is given greater protection[6] due to the greater potential for beneficial uses. As set forth in Section 2.1 of the preamble to the Utah Ground Water Quality Protection Rules (1989):

> Utah has adopted an antidegradation policy for ground water protection. Broadly this policy provides for the maintenance and protection of current and probable future beneficial uses of ground water; protection of higher quality waters at their existing water quality; and prevention of degradation of water quality that would be injurious to existing or potential beneficial water use. Thus, antidegradation incorporates many of the beneficial characteristics of both the nondegradation and differential protection policy alternatives. It recognizes that there are some effects on ground water from man's activities but limits those effects to acceptable levels. It provides a greater degree of protection to higher quality ground water. Finally it does not rule out man's economic, social or recreational activities as a strictly-applied nondegradation policy might. Although some other states profess a nondegradation policy goal, they in actual practice function as an antidegradation regulatory program.
>
> Section 2.1 of the preamble to the Utah Ground Water Quality Protection Rules (1989).

2. Under Rule 317-6-6.4A, DWQ may issue a ground water discharge permit if:

> 1) The applicant demonstrates that the applicable class TDS limits, ground water quality standards protection levels and permit limits established under R317-6-6.4E will be met;
> 2) The monitoring plan, sampling and reporting requirements are adequate to determine compliance with applicable requirements;
> 3) The applicant is using best available technology to minimize the discharge of any pollutant; and
> 4) There is no impairment of present and future beneficial uses of ground water.

3. Under Rule 317-6-6.1:

> Best Available Technology" means the application of design, equipment, work practice, operation standard or combination thereof at a facility to effect the maximum reduction of a pollutant achievable by available processes and methods taking into account energy, public health, environmental and economic impacts and other costs.

4. The ground water application provisions in Rule 317-6-6.3 provide discretion to DWQ in

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[5] Utah Admin. Code R317-6-3
[6] Utah Admin. Code R317-6-4

determining the particular information that must be submitted in an application as evidenced by the introductory sentence that provides: "*Unless otherwise determined by the Director [DWQ]*, the application for a permit to discharge wastes or pollutants to ground water shall include the following complete information . . ." (emphasis added). . Rule 317-6 applies to a wide variety of facilities with varying degrees of potential to discharge contaminants to ground water. Operational and natural site characteristics are relevant to a Rule 317-6 inquiry. Rule 317-6-6.3 lists all informational categories that may be used within the universe of permitted facilities to provide substantial evidence in the administrative record to support a finding that Rule 317-6-6.4.A has been satisfied. In other words, Rule 317-6-6.3 makes the DWQ the gatekeeper in determining what is required to be submitted to meet the requirement of Rule 317—6-6.4.A on a case by case basis, therefore not requiring applicants for a ground water discharge permit to submit information that is not relevant. To be clear, the DWQ's discretion is not without limitation, rather the discretion is exercised based upon appropriate review of the *relevant* scientific, technical, engineering or other facts related to the permit, its processes and site characteristics.

5. Subsection 1 of Rule 317-6-6.4.A (protection levels) is satisfied not only due to facility design features such as the low permeability cover of the EPS capsule designed to minimize infiltration of precipitation into the spent oil shale, but also the natural site hydrogeologic conditions. Naturally protective site conditions include an upward hydraulic gradient due to a recharge zone to the south that is at a higher elevation than the site, and the Class II Douglas Creek aquifer is hundreds of feet beneath the proposed mine and isolated from any potential discharges by several zones of low permeability oil shale.

6. Subsection 2 of Rule 317-6-6.4.A (monitoring) is satisfied in part based upon the leaching analysis that was conducted by Red Leaf Resources, the developer of the EcoShale™ In-Capsule Technology that will be used by TomCo. Red Leaf Resources has evaluated which contaminants may be leached from spent shale in contact with rainwater or snowmelt. An important feature of the proposed operation is that the EcoShale™ In-Capsule Technology does not involve containing water under hydraulic head[7]. While in the long term, a closed capsule may accumulate enough leachate that minor zones of saturation may develop on top of the lower capsule liner, the capsule design provides for the monitoring of fluid build-up to avoid the development of pressure on the lower liner from these fluids.

   The TomCo project is in the same geologic setting as the Red Leaf Resources site as demonstrated by the geologic comparison in the ground water discharge permit application[8]. Results of Red Leaf Resources' leachate analysis showed some metals and

[7]Hydraulic head is the pressure exerted by water that is proportional to the depth of the water body or the thickness of granular material containing water under saturated conditions. A positive hydraulic head is the potential driving force of liquids through a liner or other materials that underlie the water body or saturated materials.

[8] See Ground Water Discharge Permit Application, Section 11.1, pg. 99 and Appendix K.

organic compounds may leach from spent shale, and the leachate will likely have a high pH. Redleaf Resources' tests also showed low levels of total dissolved solids and non-detectable results for most metals and organic compounds. To more fully evaluate which contaminants may be present in TomCo's leachate, additional analyses are required in the permit, as described in the Statement of Basis (SOB) Part VI. The permit requires that sampling be representative of the TomCo capsule contents and that samples will be analyzed for a specified suite of organic and inorganic parameters. The best method for collecting the samples will be determined following TomCo's assessment of capsule conditions following cooling.

6. Subsection 3 of Rule 317-6-6.4.A is satisfied because TomCo is using Best Available Technology (BAT) to minimize the discharge of any pollutant based on the design of three feet of Bentonite Amended Shale (BAS) in the test capsule. Site conditions and what is known about the nature of the potential discharge justify accepting the proposed design for the EPS capsule to be BAT. DWQ's approval of the design is conservative for these conditions. The permeability of the underlying bedrock is so low that discharge from an unlined, uncapped pile of spent shale would not seep through and impair the Douglas Creek Aquifer, even if some seepage were to occur.

7. Subpart 4 of Rule 317-6-6.4.A (impairment) is satisfied because there is no impairment of present and future beneficial uses based on the complete unlikelihood of a discharge ever reaching the Douglas Creek aquifer and on the lack of any present or future beneficial use of the isolated occurrences of small, unusable quantities of Class III perched ground water at the mine site.

8. Therefore, for the reasons summarized above and as discussed in the SOB and based upon the ground water discharge permit application and other documents referenced or provided in conjunction with the application or referenced herein, and relied upon by DWQ, DWQ has concluded that the proposed facility meets these conditions so issuance of the permit is appropriate.

D. Site Conditions

The Ground Water Rules take into account varying climatic and hydrogeologic conditions related to the potential for ground water contamination as well as varying natural ground water quality. In developing permit conditions the Ground Water Rules allow these factors to be taken into account so as not to impose unnecessary conditions on permittees.

1. Climate Conditions at the TomCo Site

The climatic conditions at this site can be summarized as:

a) Arid with less than 10 inches of annual precipitation on average, see page 10 and plate one of Price and Miller.[9] An area where average precipitation is less than 10 inches is classified as a true desert.

b) Infiltration rates are very low. On page 28 of Price and Miller[10], the basin wide estimate is 3% of the average annual precipitation. At the TomCo site this would equate to an infiltration rate of no more than 0.3 inches per year. And, since the estimate is basin wide and refers to the potential for infiltration at high elevations at the southern rim of the basin, the actual infiltration rate at the TomCo site is likely even lower than 3%.

c) Evaporation (arid climate) and evapotranspiration rates are high.[11]

The climatic conditions are an important factor to consider. Because the operation does not use water in its oil shale retorting (heating) and extraction process, the only available source of water relative to the concern for potential contamination is from precipitation falling on the mine site after operations cease.

2. Hydrogeology and Ground Water Occurrence at the TomCo Site

WRA's comments revolve around the regional flow regime (i.e., the conditions under which ground water, including surface expressions such as springs, occur across much of the Southern Uinta Basin) and how these factors relate to the site specific conditions and characterization TomCo has performed. A key factor in DWQ's determination that the criteria in Rule 317-6-6.4(A) have been met is that there is no aquifer between the proposed location of the "Early Production System" or "EPS" and the Douglas Creek Aquifer. Therefore, there is no probable impairment of present and future beneficial uses of ground water.

We know there is no aquifer between the proposed location of the EPS and the Douglas Creek Aquifer because very limited amounts of water as discussed below were found in the intermediate depth monitoring wells located in the Parachute Creek Member beneath the proposed EPS location. This limited amount of water is insufficient to be of current or probable future beneficial use (see 1.1 DWQ Response). Also, the isolated water-bearing formations in the Parachute Creek Member, which is between the EPS and the Douglas Creek Aquifer, do not contain sufficiently saturated permeable material to yield usable quantities of water to wells and springs so as to meet the definition of an aquifer under Rule 317-6-1. Therefore, there is no aquifer between the proposed location of the EPS and the Douglas Creek Aquifer and no probable impairment of present or future beneficial uses of ground water.

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[9]Department of Natural Resources Technical Publication No. 49, *Hydrologic Reconnaissance of the Uinta Basin, Utah and Colorado*, 1975 by Price and Miller.
[10]Department of Natural Resources Technical Publication No. 49, *Hydrologic Reconnaissance of the Uinta Basin, Utah and Colorado*, 1975 by Price and Miller.
[11] Department of Natural Resources Technical Publication No. 49, *Hydrologic Reconnaissance of the Uinta Basin, Utah and Colorado*, 1975 by Price and Miller at pg. 12.

Moreover, the evidence indicates that water in the Parachute Creek Member around and beneath the proposed EPS location is not a source of recharge to the Douglas Creek Aquifer. This conclusion is supported by a comparison between the water quality of the intermediate depth monitoring wells in the Parachute Creek Member and the deep well in the Douglas Creek Aquifer. For instance, several dissolved and total metals concentrations from the intermediate depth monitoring wells in the Parachute Creek Member are an order of magnitude higher than the levels from the Douglas Creek Aquifer well.[12] If there were recharge we would expect similar levels of dissolved and total metals concentrations from both sampling locations.

Further, no springs are threatened based on the Fall 2013 Seep and Spring Survey.[13] A full discussion of this issue follows at 6.4 DWQ Response below.

Importantly, the proposed EPS does not pose a threat to the Douglas Creek Aquifer located hundreds of feet below the bottom of the proposed EPS. The Douglas Creek Aquifer is of relatively good quality but is naturally protected by intervening impermeable oil shale. The rocks immediately underlying the capsule construction site are lower-grade oil shale with extremely low permeability. The shale provides a protective barrier that would prevent discharges, if any, from TomCo's operations from impairing ground water.

Also, the limited quantities of water encountered in the intermediate depth monitor wells TomCo installed in the Parachute Creek Member do not constitute an aquifer as defined under Rule 317-6-1.[14] Information on the hydrogeologic characteristics of the site is presented in the SOB Part VII.2 and in the ground water discharge application, part 9. The geologic formation that includes TomCo's ore horizons and the rocks overlying and underlying them, the Parachute Creek Member of the Green River Formation (Fig. 4) is described in the geologic literature as having low[15] or minimal permeability.[16] Thus the oil shale of the Parachute Creek[17] Member of the Green River formation acts as a barrier to ground water flow and is confirmed from information collected by site investigations.[18]

Also, ground water was only encountered in three of nine coreholes drilled at the site. This demonstrates isolated occurrences of localized ground water rather than a connected flow system between the Parachute Creek Member and the Douglas Creek Aquifer. Although cores of the Parachute Creek Member show some fine to medium grained sandstones, they are either very poorly sorted (i.e., the rock matrix is sand supported by low-permeability mud), or they have been impregnated with tar and have

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12 Ground Water Discharge Permit Application at page 87.
13 Ground Water Discharge Permit Application at pages 29-33, 92,93.
14 R317-6-1 states: "Aquifer" means a geologic formation, group of geologic formations or part of a geologic formation that contains sufficiently saturated permeable material to yield usable quantities of water to wells and springs.
15 Price and Miller, pg. 10 table 1
16 Holmes and Kimball, pg. 5 table 1
17 Holmes and Kimball, pg. 6
18 Attachment A, Norwest Core Review

~~Figure 3~~

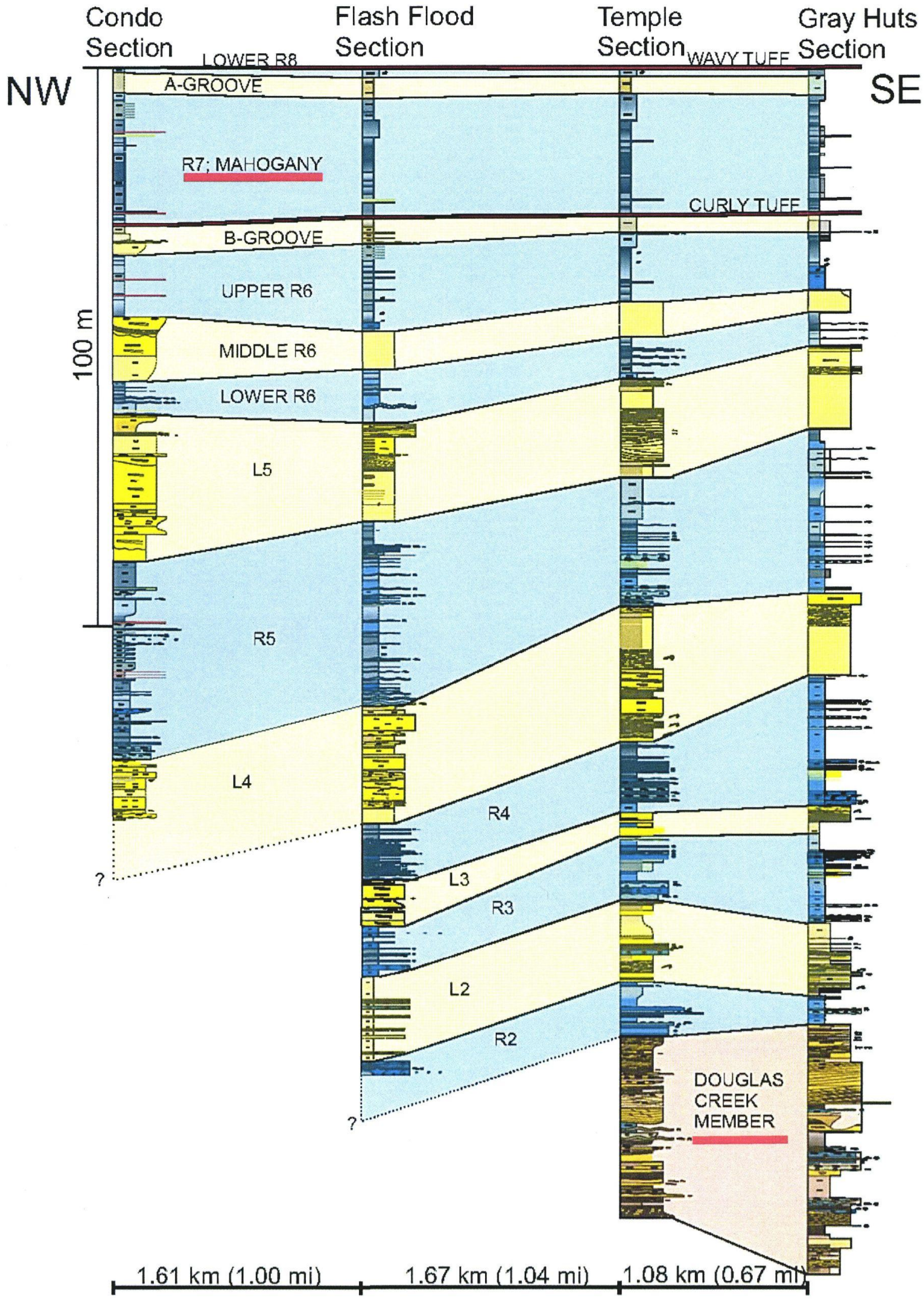

Figure 4. Generalized Stratigraphic Column Showing Relationship of Mahogany Zone and Douglas Creek Member (after Morgan Rosenburg, U. of Utah)

become impermeable[19]. This observation is further supported by results of hydraulic testing conducted on the three monitoring wells installed at corehole locations that encountered water. Specific capacities (a measure of the ability of a well to transmit water from the formation when pumped) ranged from 0.02 to 0.05 gallons per minute per foot of drawdown[20], which suggests that the well screens are in contact with material of low permeability, so any discharge would likely be restricted from significant movement.

Although WRA suggests that the Douglas Creek Aquifer may be impaired by a discharge from the EPS capsule, the evidence suggests otherwise because the Douglas Creek Aquifer[21] is contained within the part of the section of the Douglas Creek Member that is predominantly sandstone and hundreds of feet below the Mahogany Zone that will be mined (Fig. 4). The Douglas Creek Aquifer is tapped by TomCo's deep monitoring well installed to a depth of 1,100 feet below ground surface (bgs). Static water levels in the monitoring well were measured at 720 feet bgs whereas TomCo observed that the most significant water production was between 900 and 1,100 feet bgs (SOB Part VII.2). WRA's comments appear to refer to the whole Douglas Creek Member as an aquifer, rather than just the predominantly sandy part of it below the gradational contact with the overlying Parachute Creek Member.

E. Nature of the Facility

1. The type of facility being proposed is described in the permit's SOB Part III and Part IV, and in greater detail in TomCo's ground water discharge permit application. Crushed oil shale ore will be stacked in a "capsule" that will be surrounded on top, sides and bottom by liners designed for product containment during production. Only one capsule is permitted under this permit and TomCo has designated this capsule as the "Early Production System" or EPS capsule. A significant factor limiting the potential for the proposed EPS capsule to cause a discharge of contaminants is the method to be used for retorting the oil shale ore. No water or chemicals will be used in the retorting (heating) process. The contents of the capsule will be heated to approximately 725^{o} F through piping that conducts hot air (ground water discharge permit application p. 18). Gases that evolve from the ore during retorting, including water vapor, will be conducted out of the capsule, and liquid hydrocarbons that are liberated from the ore will be collected on a metal pan beneath the ore and likewise conducted out of the capsule. After retorting, the capsule contents will be extremely dry, and because of the insulating properties of rock materials, the capsule will remain hot for a long time. There will be no significant water present in the spent shale after retorting, and any significant liquid hydrocarbons will be removed from the capsule by drainage onto the metal pan. As the capsule cools, any remaining liquid hydrocarbons should solidify.

2. Because the spent shale is dry and does not contain water under saturated conditions that would lead to hydraulic head on the liner, it resembles a landfill much more than a

[19] See Ground Water Discharge Permit Application, Section 9.2.4, pg. 57
[20] See Ground Water Discharge Permit Application, Table 9-12, pg. 86
[21] Holmes and Kimball, pg. 5 Table 1

structure designed for containment of wastewater. It is not a leach pad which is constructed to contain fluids under hydraulic head. The main potential for the capsule to cause a discharge of contaminants will be from precipitation infiltrating into the spent shale and dissolving contaminants out of it. In facilities like this, resembling a landfill, the primary strategy to minimize discharge of contaminants is to install a cap over the waste material to exclude precipitation from infiltrating into the waste, to the greatest extent feasible. Although the permit allows some flexibility in liner design for this prototype capsule, TomCo has committed to a liner that is the functional equivalent of three feet of bentonite-amended shale (BAS) having saturated hydraulic conductivity of 1×10^{-7} cm/sec. This exceeds the standards required in many cases where bodies of wastewater several feet deep are impounded on an earthen liner, resulting in a hydraulic head on the liner proportional to the depth of the water. The upper liner will not be subject to a significant hydraulic head. It will be shaped to promote drainage, and vegetation will be established on the reclaimed land surface above the liner, which will promote the removal of soil water by evapotranspiration and minimize the buildup of hydraulic head on the underlying upper BAS liner.

3. Despite these efforts to prevent infiltration of precipitation through the reclaimed surface cover layers and the underlying BAS liner, some small flux of water will likely penetrate these layers and enter the spent shale underneath them. As explained in the SOB Part VIII:

> Formation of leachate and its discharge to the subsurface would only occur when precipitation infiltrates the vegetative cover and upper BAS liner in sufficient quantities to bring the water content of the near 100-foot thick layer of dry spent shale and the "rind" of insulating waste rock *to field capacity*[22], and then this water breaks through the metal oil collection pan and builds up on the lower BAS liner and breaks through it.

4. Only a small percentage of the precipitation at the site will seep through the cap layers and upper BAS liner. This small flux of water would then have to build up in the spent shale until it reaches field capacity. Modeling results presented in the ground water discharge permit application estimate approximately 2,800 years for the EPS capsule to reach field capacity[23]. This is not surprising given the dry, post-retorting state of the shale, the low precipitation at the site, the high evaporation rate and the 3 foot cap of 1×10^{-7} cm/sec BAS in addition to the re-grading, contouring and re-vegetation of the mine site.

5. As permit conditions, TomCo is required to monitor any liquids that drain from the metal pan used to collect liquid hydrocarbons during capsule operation, and also any liquids that collect on the upper surface of the lower BAS liner. Liquids will be conducted out of

[22] Field capacity refers to the point where the water content of unsaturated materials is high enough to allow gravity drainage from the base of the materials.

[23] See Ground Water Discharge Permit Application, Section 12.1, pg. 106

the capsule to monitor points that will allow these observations. Construction of these monitoring points will allow liquids that may collect on the metal pan and upper surface of the lower BAS liner to be observed, sampled and analyzed from the capsule.

6. Permit conditions must also take into account the nature of the contaminants that may be discharged to ground water. Red Leaf Resources which developed the EcoShale^{TM} In-Capsule Technology that is being utilized by TomCo, has evaluated which contaminants may be leached from spent shale in contact with rain water or snowmelt using the Synthetic Precipitation Leaching Procedure, as described in the SOB Part V, on samples taken from bench-scale test reactors. The TomCo project is located in the same geologic setting as the RLR operation as demonstrated by the geologic comparison in the ground water discharge permit application. Results of this leachate analysis showed some metals and organic compounds may leach from spent shale, and the leachate will likely have a high pH. These tests showed low levels of total dissolved solids and non-detectable results for most metals and organic compounds.

7. To more fully evaluate which contaminants may be present in leachate, additional analyses are required in the permit, as described in the SOB Part VI. The permit requires that sampling should be representative of the capsule contents and that samples will be analyzed for a specified suite of organic and inorganic parameters. The sampling methods will be determined following TomCo's assessment of capsule conditions following cooling.

II. DWQ Response to Comments

The text of the comments are restated verbatim in italics. Some of the comments are broken into subparts for purposes of the DWQ's response.

Comment 1 (1.1)

Thank you for the opportunity to comment on the draft for Ground Water Discharge Permit (GWDP) No. UGW470003. These comments are submitted on behalf of Living Rivers.

Initially, it should be noted that the approach adopted by the Director of the Division of Water-Quality (Director) to permitting the Early Production System (EPS) capsule undermines any attempts to verify whether or not the EPS capsule design will perform commensurate with the company's claims. Rather than recognize this proposal for what it is- a first-generation proof-of-concept design requiring monitoring and verification- the Director has marginalized numerous reports of ground water at the mine site that could be impacted by this operation and in the process of doing so has failed to require the company to conduct any monitoring of shallow ground water.

1.1 DWQ Response

The regional geology and hydrogeology of the Uinta Basin has been the subject of several studies and was summarized in Section 9 of the ground water discharge permit application (p.35). In addition to researching previous ground water studies of the region, TomCo researched all oil and gas wells, water rights, and drinking water sources within a 1-mile radius of the mine property[24]. In 2010, site-specific information was obtained by advancing 9 coreholes distributed across the site (ground water discharge permit application Figure 9-1) ranging in depth from 116 to 304 feet below ground surface bgs. Based on information obtained from the 2010 drilling program, in 2013 three intermediate depth monitoring wells were completed in the Parachute Creek Member and one deep monitoring well was installed in the Douglas Creek Member[25]. So, reports of ground water in the region and at the site have not been marginalized, rather they have been well documented as summarized further below.

Because only three of the nine borings resulted in shows of water, subsurface water in the Parachute Creek Member is limited, both in spatial extent and in its ability to migrate vertically. Even in places where the permeable sandstones have the localized potential to hold limited quantities of water, the groundwater in these perched lenses is unlikely to migrate because the sandstones are discontinuous and surrounded by impermeable shale.

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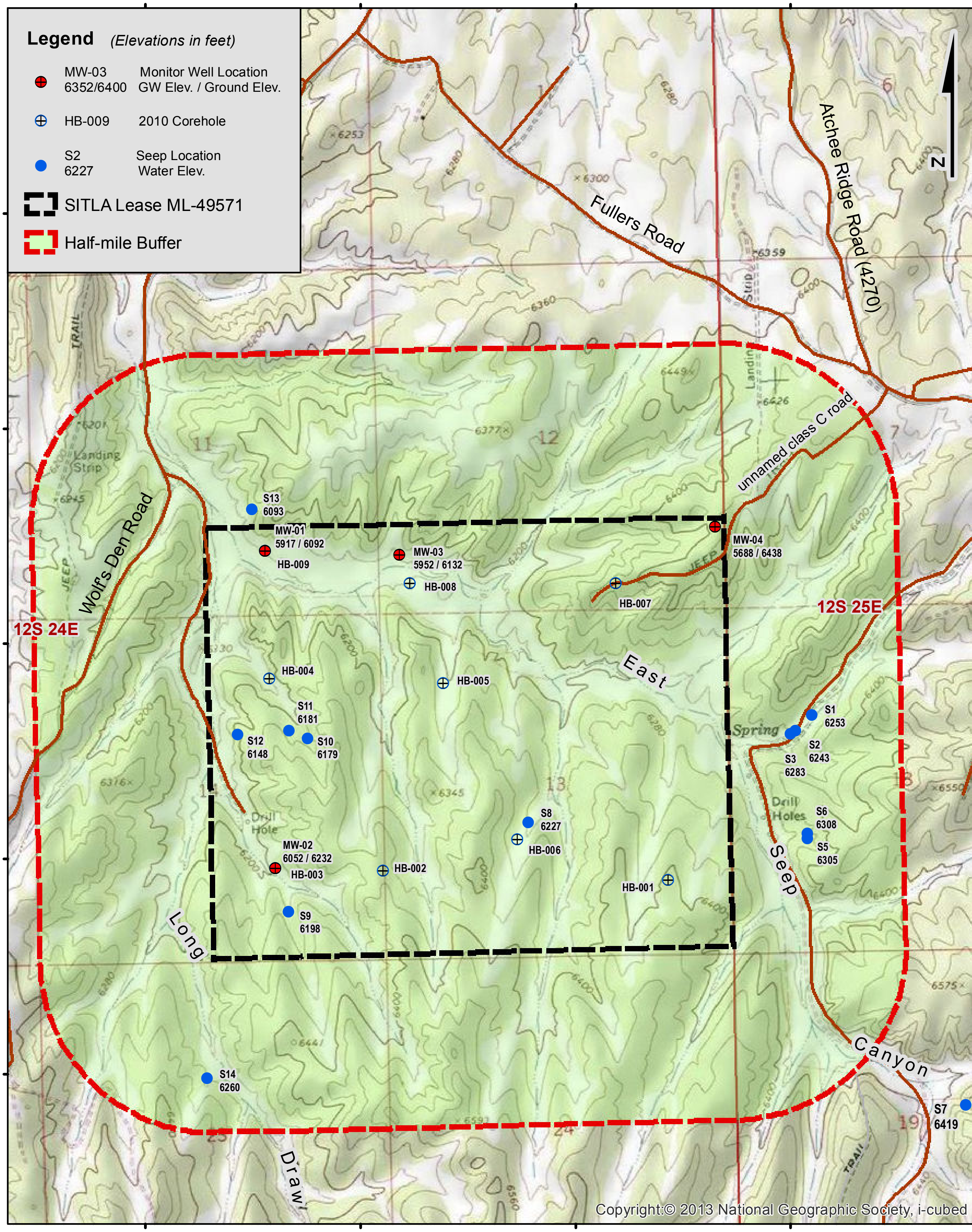
[24] See Ground Water Discharge Permit Application, Section 7, pg. 29
[25] See Ground Water Discharge Permit Application, Section 9.2.3, pg. 45



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NAD 1983 UTM Zone 12N
USGS Topographic Base

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Figure 9-1
Project Area Features
The Oil Mining Company, Inc.
Uintah County, Utah

The six intermediate depth borings installed by TomCo that were devoid of water are not feasible ground water monitoring points.

To gather site-specific ground water data, three monitoring wells were installed in the locations that had shows of groundwater. The monitoring wells produced unusable volumes, as the largest quantity produced from any of the wells during pumping tests was 6.8 gallons[26,27]. The recovery of water in this well was continuously monitored for approximately 8 days and the last recorded depth to water was still 9.24 feet below the level of initial pumping[28], indicating recharge of the 6.8 gallons had not been achieved given over 1 week to recover. This is not indicative of a shallow aquifer, but rather the expression of discontinuous sandstones that are believed to represent fluvial channel deposits, and do not provide the potential for an interconnected ground water flow system. Isolated saturated zones of ground water interspersed throughout the vadose zone that yield unusable quantities of water do not meet the definition of an aquifer under Rule 317-6-1 which defines an aquifer as "….part of a geologic formation that contains sufficiently saturated permeable material to yield usable quantities of water to wells and springs."

The objective of monitoring is to detect a release as soon as possible. If the EPS were to fail, the most effective and timely monitoring points would not be shallow monitoring wells installed with the intent to monitor discontinuous saturated ground water zones. Rather, DWQ has determined the more representative monitoring point to detect potential releases from the EPS are the monitoring ports designed to monitor the same surface installed to capture the oil produced inside the EPS (oil collection pan), the lower BAS immediately beneath the oil collection pan (secondary containment), and finally the "french drain" (as referred to by WRA) is designed to capture any fluids should they escape the lower BAS and reach the bedrock surface upon which the EPS will be constructed.

<u>Comment 1 cont.(1.2)</u>

As with the Red Leaf GWDP for the EPS capsule, one of the stated purposes of the TomCo GWDP is to allow the company and the Director to gather adequate information through monitoring and testing to determine whether a GWDP could be issued for commercial-scale development, and if so, what permit terms and conditions would be necessary to protect ground waters of the state. In other words, one of the primary functions for constructing and testing the EPS is to determine whether the design of the capsule will perform as expected. For that reason, verifying the results of that testing is of critical importance. In

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[26] MW-02, See Ground Water Discharge Application, Table 9-5, pg. 71

[27] For perspective on what might be considered a "usable quantity" of water, the Utah Division of Water Rights provides quantities (refer to "Water Use Information for Water Right Applications" webpage revised June 24, 2003) that are used on water right applications to generally quantify volumes for various categories such as domestic use or stockwatering. Annual usage for a fulltime permanent residence is 0.45 acre-foot per family. One acre-foot is 325, 851 gallons, so the annual usage for a residence is 146,633 gallons per year. Stockwatering for a cow or horse is 9,123 gallons per year. Assuming the monitoring well reached full recovery every 8 days, and could be converted to a production well, it has potential to produce 303 gallons per year.

[28] See Ground Water Discharge Permit Application, Table 9-5, pg. 71

order to determine whether or not, for instance, the design of the EPS will prevent release of contaminants into the environment, the Director must require the company to undertake a stringent monitoring regimen as an essential part of this permit. An adequate regimen would include, for example, monitoring of the documented shallow ground water aquifers at the mine site and the local seeps and springs that may well be connected to those aquifers. Because TomCo will not be required to conduct or report any such monitoring, the Director will necessarily be unable to determine to any reasonable degree whether there is a sufficient basis for permitting commercial-scale development.

1.2 DWQ Response

The DWQ is issuing a permit for one EPS capsule. The construction of additional capsules, if proposed, would require a stand-alone ground water discharge permit application that would be evaluated separately on the content provided in that document.

The DWQ has determined that the Douglas Creek Aquifer is naturally protected by the overlying low permeability geologic layers. As a result, the Douglas Creek Aquifer is not the appropriate compliance monitoring point for early detection of a release of contaminants to the environment. Likewise, attempting to monitor discontinuous occurrences of low-volume perched ground water within the vadose zone has a low probability of detecting a failure of the integrity of the EPS capsule. Rather, the most immediate monitoring locations for evaluating the integrity of the EPS design are: the monitoring ports installed to monitor the same surface designed to capture the oil produced inside the EPS (oil collection pan); the lower BAS immediately beneath the oil collection pan (secondary containment); and lastly, the french drain designed to capture any fluids should they escape the lower BAS and reach the bedrock surface upon which the EPS will be constructed.

As discussed in 1.1 DWQ Response, there is no aquifer between the EPS and the Douglas Creek Aquifer. As discussed in 6.4 DWQ Response there is no threat to seeps and springs.

Comment 1 cont.(1.3)

In order to comply with the law, the Director is obligated to issue a permit that requires the company to conduct sufficiently rigorous sampling and analysis of the performance of the EPS to ensure protection of ground water, R317-6-6.3(I) and R317-6-6.4, to perform timely and thorough analysis of both the toxic characteristics of the spent shale within the EPS and the discharge rate emanating from the EPS, R317-6-6.3(F) and R317-6-6.4, to provide complete and accurate descriptions of the geology and hydrology in the area of the mine, R317 -6-6.3(E) & (K) and R317-6-6.4, and to provide whatever information is required to show that any possible discharges from the EPS will not threaten waters of the state. R317-6-6.3(G) and R317-6-6.4. Additionally, in order to ensure adequate protection of the shallow aquifers beneath the mine, as well as area seeps and springs, the Director must require the company to install a geomembrane liner beneath the capsule containing a leak detection system. Because the Director has failed to meet these regulatory requirements, and because he is not requiring the company to adequately protect waters of the state, his *decision to approve TomCo's GWDP is arbitrary, capricious and a violation of the law.*

1.3 DWQ Response

As set forth in the Introduction above, the ground water application provisions in Rule 317-6-6.3 provide discretion to DWQ to determine the information that must be submitted in an application in order for the DWQ to find that the requirements of Rule 317-6-6.4.A. have been satisfied. Among the following reasons, DWQ found the information provided by TomCo was sufficient and the issuance of the Permit appropriate.

There are no planned discharges from the EPS capsule. There is no expectation that fluids will be produced after the oil production phase of the project is over, but if fluids are produced, Part II.D of the permit requires TomCo to collect and characterize the fluid and obtain DWQ approval prior to selecting a disposal method.

Part II.F.(2) of the permit requires TomCo to characterize the spent shale within 2 years of the cessation of capsule heating using both the Synthetic Precipitation Leaching Procedure (SPLP) and the Meteoric Water Mobility Procedure (MWMP). In addition, SPLP samples have already been analyzed from spent shale derived from bench scale testing conducted at the RLR site as presented in the ground water discharge permit application[29].

The hydrogeology report presented as Section 9 of the ground water discharge permit application presented a complete and accurate description of the geology and hydrogeology in the area of the mine. The report included: an overall description of the regional geology based on published geologic maps and reports; stratigraphy of the area based on published data, including the well log from the nearest oil well to the site (Hot Rod Oil Government Chorney B-NCT-1); nine site-specific coreholes drilled by TomCo on the property; and four monitoring wells TomCo installed at the site. Site-specific data collected from the monitoring wells includes water quality data, drawdown and recovery rates, and a borehole geophysical log from MW-4.

Contrary to the comment, there are no shallow aquifers beneath the mine (see 5.1. DWQ Response). Seeps and springs are not at risk from mine operations (see 6.4 DWQ Response).

Rule 317-6-6.4 requires the Director to determine that the applicant is using best available technology to minimize the discharge of any pollutant, it does not require a geomembrane liner and leak detection system. In this case, the Director has determined the EPS capsule design satisfies best available technology. The EPS capsule design includes, among other things, both an upper and lower 3-foot layer of BAS constructed with a saturated hydraulic conductivity of 1×10^{-7} cm/sec to both prevent infiltration of precipitation into the capsule, and the release of fluids out of the capsule.

[29] See Ground Water Discharge Permit Application, Section 11.2, pg. 100

Permit Action: None.

Comment 2 (2.1)

The Permit Must Contain a Detailed Sampling and Analysis Monitoring Plan

Pursuant to R317-6-6.3(F), TomCo is required to identify the characteristics of its effluent or leachate. In order to accomplish this, the Director has briefly outlined requirements for the monitoring of drainage from the capsule, for the analysis of spent shale and for the evaluation of the upper BAS liner performance. GWDP at 5-6. However, rather than requiring the company to finalize the sampling and analysis plan as part of its GWDP Application (Application), the Director has chosen to defer this regulatory requirement until some indefinite point in the future. Id. By taking this approach, the Director is ignoring the plain language of R317-6-6.3(F) and R317-6-6.4, under which it is necessary to determine whether contaminants emanating from the capsule have the potential to harm local ground water. Instead, the Director has tied the requirement to finalize the sampling and analysis monitoring plan to completion of construction and testing of the EPS, which will theoretically occur at some future date. This approach by the Director violates the requirements outlined in R317-6-6.3 and R317-6-6.4, and deprives the public of the opportunity under R317-6-6.5 to meaningfully comment on how the Director and the company intend to meet this regulatory obligation.

2.1 DWQ Response

The requirements of Rule 317-6-6.3 have been met. As discussed in the Introduction, Rule 317-6-6.3 lists all informational categories that may be used within the universe of permitted facilities to provide substantial evidence in the administrative record to support a finding that Rule 317-6-6.4.A has been satisfied. However, Rule 317-6-6.3 gives the DWQ discretion to determine from this list information it needs in order to make this finding. DWQ is satisfied that requiring the Sampling and Analysis Plan (SAP) in the compliance schedule is adequate and justified. The purpose of a SAP is to insure that data collected during the time that monitoring is required is consistent over time. A SAP contains methods of sample collection, parameters to be analyzed, sample preservation and transport, and analytical methods to be used at the laboratory. A SAP is intended to be used to insure continuity of sampling methods even if different personnel conduct the sampling over time. It can only be changed with approval of the DWQ.

TomCo has preliminary designs for the sample ports to be used for collecting any liquids from the EPS capsule's metal collection pan, the top of the lower BAS liner, and the surface between the capsule and the underlying bedrock after production is complete. Because the SAP must include detailed instructions on how to obtain a scientifically valid sample from these ports, that part of the SAP cannot be finalized at this time. Also, the full suite of analytical parameters will not be known until TomCo completes the spent shale analyses required in the permit. Because of these factors, the inherent protection of ground water due to natural site characteristics, and the low likelihood of leachate discharge during this permit term, DWQ is satisfied that it is not necessary that a SAP be entirely completed before permit issuance.

DWQ's evaluation of the ground water discharge permit application and issuance of the permit is compliant with Rule 317-6 because it was based on factual, scientific and technical data. DWQ has used the available operational and site conditions as provided in the ground water discharge application, as well as described in the SOB, to determine that the risk to ground water at the site is minimal due to natural conditions and that, given the arid nature of the site location, the time for any infiltration into the capped, graded, re-claimed and re-vegetated EPS is on the order of hundreds of years. Therefore, DWQ has concluded that the sampling and monitoring plan is adequate to determine compliance with permit requirements.

<u>Comment 2 cont. (2.2)</u>

In addition to requiring TomCo to analyze spent shale using the Synthetic Precipitation Leaching Procedure (SPLP) and Meteoric Water Mobility Procedure (MWMP) methods, the Director must also require the company to conduct testing using the Toxic Characteristic Leaching Procedure (TCLP) method. The TCLP method is used to determine if a waste is hazardous under the Resource Conservation and Recovery Act (RCRA) and is designed to determine the mobility of both organic and inorganic analytes present in liquid, solid and multiphasic wastes. Jim Kuipers' January 26, 2015 Expert Report (Kuipers) at 6, Exhibit A attached. Given that U.S. EPA has not determined whether waste from the EPS capsule will be considered hazardous under RCRA, the Director is compelled to require TomCo to use this methodology to test its wastes.

Because there is no valid reason for the Director's decision to waive the requirement that the company submit a sampling and analysis plan as required by R317-6-6.3(F) as part of its Application and instead to defer such a submission until some uncertain future date the Director's action is arbitrary and capricious and a violation of the law.

<u>2.2 DWQ Response</u>

TCLP uses an acetic acid extraction that mimics conditions in a municipal landfill, and is used to determine if a particular waste is hazardous under RCRA. Because all available information suggests that the spent shale will be highly alkaline, and because it is not the purpose of Rule 317-6 to define or regulate hazardous waste, it is inappropriate to require TCLP analysis for this permit. Instead, the Meteroic Water Mobility Procedure (MWMP) is the more representative test. The MWMP analysis is a requirement under Part II.F.2 of the ground water discharge permit.

The requirement to submit a SAP has not been waived. Part II.F.1 of the ground water discharge permit requires submission of a SAP with a due date that is not yet determined, but it is tied to a construction milestone that is fully enforceable by DWQ.

Permit Action: None

Comment 3 (3.1)

The Permit Must Require TomCo to Excavate the Decommissioned Capsule to Verify Performance of the BAS Liner and Other Critical Infrastructure Components.

In its Application, the company has stated that it is considering alternative design and construction methods for the bottom, side and cover BAS layers. Application at 20-21. However, the lack of monitoring of most of the capsule exterior will not allow the Director to determine whether the BAS liner will remain intact across a large portion of the capsule surface. Because of this, the lack of post-testing evaluation or monitoring of the BAS liner is a fatal flaw in the company's plan and the resulting GWDP. While the company is appropriately proposing to construct a prototype of sufficient scale in order to examine the impacts that the retort process has on the BAS liner and other critical components such as the metal sheet, the company must excavate the decommissioned capsule. Kuipers at 4. Without such excavation, there is no way for the company or the Director to evaluate the results of the testing process. Id. The Director should require the company to excavate and examine the degradation of the liner system and its integrity relative to the EPS test conditions. Id. This is especially important given that the BAS and insulating gravel units were not included in the preliminary backing wall stability analysis and that these aspects of the EPS represent potential weak layers in the design. Id.

As Mr. Kuipers notes, the stability of the backing walls and the integrity of the BAS liner will be adversely affected by the heat and pressure generated within the capsule during the retorting process and should be evaluated as part of the EPS testing. Id. Liner integrity is likely to be degraded due to heat and other conditions such as the pressure and associated solution contact in the form of retort gas and liquid products. Id. The wetting and drying of the BAS liners can result in material shrinkage and desiccation. Id. Also, potential chemical alteration of the liner through events and processes such as ion exchange could also compromise the integrity of the BAS liner. Id. Should any of these occur, the stability of the capsule and the integrity of the liner could be adversely affected and, in those conditions, it is highly likely that this would result in the release of pollutants to the environment. Id.

Further, the steel plate referred to as the "oil collection pan" is novel to the proposed capsule and it is highly likely that the metal sheet will be affected by the heating and pressurization process as well as the weight and settling of the material. Id. at 4-5. This will cause warping and weld failures in the metal sheet which will result in leaking of the sheet and, in turn, an increased reliance on the BAS liner to prevent discharge of pollutants. Id.

Beyond degradation of the BAS liner and the oil collection pan, the proprietary fabrications associated with the BAS seal function are also a concern. Id. at 5. Based on evaluation of similar designs under less onerous conditions, there is a high likelihood of failure of the liner *seals due to the heated and pressurized retort environment. Id. Such a failure would likely result in discharge of pollutants from the capsule. Id. Additionally, there is a significant potential for differential settling within the capsule- with some portions of the capsule settling more than others- over a longer time period (years versus months) than is currently being predicted. Id. While the EPS testing will examine issues such as differential settling, the permit does not account for the possibility that this settling may continue to occur over a period in excess of 5 years and potentially for up to 25 years or more. Id.*

In order to adequately evaluate the design of the capsule for the purposes of future permitting, it is necessary for the Director to require TomCo to conduct post-testing excavation of the capsule. Because the Director is not requiring TomCo to conduct such excavation in order to verify the performance of the EPS and critical capsule components, there is no way for him to verify whether the EPS will perform as expected as required by R317-6-6.3(G) and R317-6-6.4. Therefore his decision not to require post-testing excavation is arbitrary, capricious and a violation of the law.

3.1 DWQ Response

Excavation of the decommissioned capsule is not necessary. Part II.F.3 of the Permit requires TomCo to conduct an evaluation of the upper BAS liner after the capsule has been heated and cooled. The plan prepared to guide this study is a compliance schedule requirement since details of how the study is conducted may change depending upon actual construction and performance of the EPS capsule.

First and foremost, ground water is protected by site conditions. From an engineering perspective, re-contouring and re-vegetation of the final capsule surface is what prevents infiltration through the capsule and protects ground water, not the lower BAS liner. As explained in Part I.E. (Nature of the Facility) of the Introduction to these comment responses, significant amounts of water will not collect on the lower BAS liner, and there will be no significant force driving fluids through it. The closed capsule will resemble a landfill, and leachate generation will be minimized by the upper BAS liner. The lower BAS liner is not a critical component to insure the conditions for issuing a ground water discharge permit are met. TomCo is required to construct an upper BAS cap with a 1×10^{-7} cm/sec hydraulic conductivity. If this is unachievable, TomCo is required to maintain a cap with the functional equivalent of three feet of material with hydraulic conductivity of 1×10^{-7} cm/sec. To confirm the performance of the BAS cap, a post-closure evaluation required under part II.F.3 of the permit will be conducted after heating and cooling is completed. TomCo is required to evaluate the condition of the upper cap after capsule closure, focusing on the most likely places where its integrity may be compromised.

Prior to approval by DWQ, the Reclamation Plan required under part II.F.4 of the Permit will address ongoing inspections of cover settlement and capsule integrity when there is more data regarding actual construction and performance of the EPS.

Permit Action: None.

Comment 4 (4.1)

The Director Must Require TomCo to Install a Liner and Leak Detection System as Part of the Permit Terms and Conditions.

While the operation of the EPS capsule is being proposed as a zero-discharge operation that will include primary and secondary containment, beyond the primary BAS containment liner, there is no secondary containment associated with TomCo's operation. Kuipers at 5. The French-drain system proposed by TomCo does not constitute an adequate drainage and capture network. Id. As noted above, Mr. Kuipers points to a number of possible EPS capsule failure points that could result in a significant discharge of pollutants to waters of the state. While the Director is treating the bedrock foundation for the capsule as impermeable, the company notes in its application that springs close to the mine may be the result of fractured bedrock. Application at 43-44; see also Elliott Lips' January 22, 2015 Expert Report (Lips) at 4. In order to protect waters of the state adequately, the Director must require TomCo to install a redundant liner and leak detection system. Kuipers at 5; Lips at 12. Such a system would consist of a geomembrane liner overlain by a geogrid draining to a collection point. While the French-drain system proposed by the company could capture some of the pollutants that escape the EPS capsule, there is no guarantee that it would capture most or all of those pollutants and would not help the company pinpoint where any failure in the capsule has occurred.

Because there are a number of possible failure points within the EPS capsule that could result in a significant discharge of pollutants to waters of the state, because there is no assurance that the proposed French-drain system will capture most or all of the pollutants that escape the capsule, and because the bedrock beneath the capsule has been determined to be prone to fracturing, it is imperative that the Director require the company to construct the EPS capsule on a liner system incorporating a leak detection system. Because he has not, the Director's decision to approve the GWDP in its current form is arbitrary, capricious and a violation of the law.

DWQ Response 4.1

TomCo's ground water discharge permit application represented the capsule design as a "zero discharge" facility[30], but from DWQ's perspective, a zero discharge is not necessary for permit issuance because of the site conditions described in the Introduction above. As explained in the SOB Part V, TomCo's capsule technology does not use process water and does not involve containment of wastewater. Discharge of contaminants to the subsurface related to the oil shale retorting process would only occur as a result of precipitation infiltrating into the closed capsules and reacting with the spent shale remaining after extraction of hydrocarbon liquids and gases. Liners that are mainly intended for product containment provide added protection, but the permit is not based on a zero-discharge design for the EPS capsule which would be an excessive standard in this case because there are several hundred feet of impermeable shales beneath the proposed location of the EPS capsule and the Douglas Creek Aquifer. Instead, site conditions (the impermeability of the oil shale of the Parachute Creek Member of the Green River formation acts as a barrier to ground water flow) and what is known about the nature of the potential discharge (potential leachate has similar or better water quality than the limited shows of groundwater encountered in the Parachute Creek Member[31]) justify accepting the proposed design for the EPS capsule to be Best Available Technology. DWQ's approval of TomCo's design is conservative for these conditions. The permeability of the underlying bedrock is so low that discharge from an unlined, uncapped pile of spent shale would not seep through and impair the Douglas Creek Aquifer, even if some seepage were to occur.

Permit Action: None.

Comment 5 (5.1)

The Application Fails to Accurately Characterize the Geology and Hydrology in the Area of the Mine.

The Utah Ground Water Quality Protection regulations require TomCo to submit information related to the geology and hydrology of the affected area. Specifically, R317-6- 6.2(E) requires an application to provide "[g]eologic, hydrologic and agricultural description of the geographic area within a one-mile radius of the point of discharge, including soil types, aquifers, ground water flow direction, ground water quality, aquifer material, and well logs." Additionally, R317-6-6.2(K) requires the applicant to provide:

[t]he description of the ground water most likely to be affected by the discharge, including water quality information of the receiving ground water prior to discharge, a description of the aquifer in which the ground water occurs, the depth to ground water, the saturated thickness, flow direction, porosity, hydraulic conductivity, and flow systems characteristics.

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[30] This representation may be based on TomCo's economic interest in collecting as much of the oil as possible.

[31] For instance, see Figure 9-13 discharge water from MW-03, Ground Water Discharge Permit Application at p. 85.

While some of this information is contained in the Application, TomCo fails to provide the complete and accurate descriptions required by these regulations.

The aquifers located immediately beneath the mine site are contained within the lower portions of the Parachute Creek Members. Lips at 4. In the three monitoring wells that Tom Co drilled in 2013, the company detected the presence of ground water that would be classified as Class II Drinking Water Quality Ground Water and Class Ill Limited Use Ground Water with flows ranging from .48 gallons per minute to 1.33 gallons per minute. Lips at 4; see also Application at 90. In 2014, TomCo conducted pump and recovery tests that revealed that the aquifers in the Parachute Creek Member immediately beneath the proposed mine range in saturated thickness from 10.34 to 26.54 feet, that the geologic materials have sufficiently high permeabilities to allow for sustained pumping of up to .39 gallons per minutes into the wells, that two of the three wells recovered to pre-test water levels in about 8 days and that the values estimated by TomCo are in agreement with published values for other geologic materials capable of storing and transmitting sufficient quantities to wells and springs. Lips at 5-6.

However, while the Application contains information related to the three monitoring wells, TomCo did not provide the required geologic and hydrologic descriptions for the entire site. While showing that Class II and Class III water exists in shallow aquifers immediately beneath the mine site, TomCo failed to provide information on how the aquifers are connected, the specific flow directions, flow systems characteristics or points of discharge. Lips at 6. Further, Tom Co failed to analyze the significance of secondary porosity, even though the company acknowledged the presence of bedrock fractures that could provide a hydrologic connection between the Parachute Creek Member and the Douglas Creek Member. Lips at 6; see also Application at 44. Additionally, TomCo's application fails to evaluate any hydrologic connection between the aquifers in the Parachute Creek Member and the nearby seeps and springs. Lips at 6. Because the Director does not require TomCo to accurately describe the geology and hydrology of the mine site as required in R317-6-6.3(E) & (K), his decision to approve the GWDP is arbitrary, capricious and a violation of the law.

5.1 DWQ Response

Based on the results of water quality samples collected from the three intermediate depth monitoring wells installed in 2013, the ground water would be classified under R317-6-3.6 as Class III – Limited Use Ground Water. TDS values in 2 of the wells exceeded the Class II limit of 3000 mg/l. One of the wells had a TDS lower than 3000 mg/l, but exceeded water quality standards for antimony and fluoride which makes it Class III[32].

None of these wells produced sustainable flow rates during stress tests conducted during the fall of 2014 with the specific purpose of determining what, if any, flow rate each monitoring

[32] See Ground Water Discharge Permit Application, Table 9-13, pg. 88

well could sustain[33]. Depth to water in the wells ranged between approximately 174 to 190 feet below ground surface (bgs). Pumping rates varied to accommodate different depths to water in wells, while maximum discharge rates ranged from 0.24 gpm in MW-01 to 0.34 gpm in MW-03. Despite these low discharge rates, each well was evacuated after removing volumes ranging between 3.14 to 6.8 gallons. Water levels were then monitored for approximately 8 days during which none of the wells fully recovered to the initial level measured prior to pumping. None of these measurements are representative of an aquifer as incorrectly assumed by WRA's exhibit, Lips at 4. Lips assumes there are "aquifers" underlying the EPS capsule site at shallow depths. This conclusion shows a misunderstanding of the nature of the geologic contact between the Parachute Creek Member and the underlying Douglas Creek Member, and confusion of the Douglas Creek Member with the aquifer contained within that member and as R317-6-1(1.1) states an aquifer may be "….part of a geologic formation that contains sufficiently saturated permeable material to yield usable quantities of water to wells and springs."

The contact between these two members is gradational, alternations of fine-grained rock deposited in a deeper water environment with coarser-grained rocks deposited in a more shallow water environment. Sandstones deposited in a shallow water environment, subject to waves and currents, may have relatively high permeability and may contain water-bearing zones which produce sufficient quantities of water to constitute an aquifer if they have sufficient pore space between the sand grains, and if there is source for water to recharge into the sandstone. This "primary porosity" may be enhanced by fractures in the rock, termed "secondary porosity". The stratigraphic relationship between the Parachute Creek and Douglas Creek Members is illustrated in detailed measured sections taken at an outcrop of the two members along Evacuation Creek, approximately 7 miles northeast of the TomCo site[34]. Details of the stratigraphy will be different between the Evacuation Creek sections and the TomCo site, but the larger-scale stratigraphic relationships will be similar. In a gradational sequence such as this, picking a contact between the two members is arbitrary, and there is often no consistent agreement of the contact among geologic workers in the region. The U. S. Geological Survey picks the contact at the first sandy bed below the Mahogany oil shale bed, shown in the type stratigraphic column illustrated in Figure 9-2 of TomCo's ground water discharge permit application. The Utah Geological Survey places the contact at the base of the R2 oil shale zone, as shown on Figure 4 of this response. The Douglas Creek Aquifer is contained within the part of the section that is predominantly sandstone. This aquifer is tapped by TomCo's deep well, which encountered ground water between 900 and 1,100 feet below ground surface (SOB Part VII.2). WRA's comments appear to refer to the whole Douglas Creek Member (USGS interpretation) as an aquifer, rather than just the predominantly sandy part of it below the gradational contact.

The Douglas Creek Aquifer is several hundred feet deeper in the Douglas Creek Member and isolated from the upper sandy beds by several zones of oil shale. There is no evidence that the sandy bed below the Mahogany Zone is an aquifer, and significant evidence that it is not.

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[33] See Ground Water Discharge Permit Application, Section 9.3.3.2, pg. 69
[34] (Fig. 4 of this response)

Examination of drill cores of the Parachute Creek Member do show some fine to medium grained sandstones; however, they are either very poorly sorted (i.e., the rock matrix is sand supported by low-permeability mud), or they have been impregnated with tar and have become impermeable as a result[35].

The site-specific data TomCo has collected and presented in the ground water discharge permit application is consistent with the geologic literature describing geology and hydrology of the Southern and Southeastern Uinta Basin. DWQ has determined that adequate information is known about the geology and hydrology of the area such that the EPS operation is unlikely to have an effect on the water quality that results in impairment of present or future beneficial uses of the Douglas Creek Aquifer. As a result, the DWQ is satisfied that the characterization of the geology and hydrology in the area sufficiently supports the issuance of the permit.

Permit Action: None

Comment 6 (6.1)

The Application Contains an Incomplete and Inaccurate Description of Springs in the Project Area.

TomCo's Application only contains a single reference to a seep and spring survey conducted by the company in October 2013. This survey, conducted when discharge from seeps and springs is typically at its lowest point, is insufficient to quantify the extent of seeps and springs within the affected area. Lips at 6. Eight of the twelve seeps and springs identified by TomCo in the area of the mine had sufficient flow to obtain samples for water analysis, and this analysis showed that based on the TDS values from these water sources (750 mg/1- 1,790 mg/1), these water sources qualify as Class II Drinking Water Quality Ground Water. Id.

6.1 DWQ Response

The comment is incorrect in stating that seeps and springs are Class II, despite the TDS sample range noted in the comment because the criteria for establishing ground water classes under Rule 317-6-3 includes a contaminant concentration component in addition to a TDS value. Water quality data collected during the seep and spring survey was collected with field instruments and must be considered screening level data. Filling a container to submit for laboratory analysis to determine contaminant concentrations was not practical because the seeps were only damp to wet, and did not even produce measurable flow, let alone allow for the filling of a laboratory container[36].

[35] See Ground Water Discharge Permit Application, Section 9.2.2, pg. 44
[36] See Ground Water Discharge Permit Application, Section 9.3.2.5, pg. 92

If the assumption that there is a seasonal component to the presence of the seeps and springs is correct, and flows are reduced or non-existent at certain times of the year, it provides further evidence as to the limited volumes of shallow ground water present in the area. Ephemeral occurrences of water flow are more closely associated with surface water run-off and shallow infiltration following precipitation events rather than expressions of a permanent ground water flow system.

Comment 6 cont. (6.2)

TomCo's observation that almost all of the seeps and springs appeared to originate in or near drainage channels, at points where shale layers were exposed, suggests that these water sources are locations of discharge from the aquifers present in the Parachute Creek Member beneath the mine site. Lips at 6, Application at 93. However, the Application does not include any geologic or hydrologic descriptions of the aquifers from which these seeps and springs originate, thus failing to determine whether these water sources would be impacted by the mine. Lips at 7.

6.2 DWQ Response

The evidence shows there are no aquifers in the Parachute Creek Member beneath the mine site as described in 5.1 DWQ response above.

The observation that almost all of the seeps and springs originate near drainage channels or at points where shale layers were exposed[37] suggest these water sources are expressions of surface water run-off and infiltration of precipitation flowing laterally along the impermeable shale layer until it seeps out at the drainage channel exposure. Surface expression of a shallow aquifer would be perennial (stream, lake, etc.) representative of a permanent ground water flow system.

Comment 6 cont. (6.3)

TomCo claims that the two documented springs will not be affected by pollutants from the mine because they are located upgradient of, and approximately 80 feet higher than, the highest mine excavation planned. Application at 93. However, as Mr. Lips points out, Figure 9- 1 of the Application shows the water levels of the two springs at 6,253 and 6,283 feet, while Figure 5-1 shows that the highest elevation of disturbance at the mine is approximately 6,470 feet and that the final pit floor will be between 6,330 and 6,270, indicating that the springs are actually located 187-217 feet lower than the highest mine excavation. Lips at 7.

[37]See Ground Water Discharge Permit Application, Section 9.3.2.5, pg. 93

6.3 DWQ Response

As noted in footnote (a) of Table 9-14 in the ground water discharge permit application, elevations of the seeps and springs obtained in the field were not collected with survey grade accuracy. This lack of accuracy is illustrated by the fact that S3 (elev. 6283), located lowest in the drainage channel, has a higher elevation than S1 (elev. 6253), located higher in the drainage channel, which is incorrect. Contour lines on the USGS topographic base map used for Figure 9-1 of the ground water discharge permit application show S1, S2, and S3, which plot very close together, to be nearest the 6,320 elevation contour. Despite inaccurate elevation data, the contour map shown on Figure 9-1 clearly shows that the referenced springs are located in a drainage trending NE-SW that flows to the SW into East Seep Canyon, which drains a W-NW direction. Topographically, any surface flow originating along the east side of the mine site (side nearest the springs), would flow into East Seep Canyon and could not reach the springs without flowing uphill, therefore mine site activities are not a threat to the noted springs.

Comment 6 cont. (6.4)

Additionally, the company claims that the springs are upgradient of the planned excavation and that their recharge area is towards the northeast. However, the company provides no data to support this contention and the Application contains no reported ground water investigations with measured ground water elevations from which any gradients could be determined. Id.

As established above, the information in the Application actually supports the conclusion that direction of the ground water flow would be to the north, from the area of the mine to the springs, and that the springs are indeed down gradient from the mine. Id. Because the water from these sources is uniformly Class II, and given that the springs are down gradient from the mine, it is imperative that the Director require the company to obtain the additional information required by R317-6-6.3(K). As part of securing this additional information, the company must:
1) document seasonal variability in ground water flow at the seeps and springs already identified
a; 2) determine flows at the 12 seeps identified in the October 2013 survey; and, 3) identify additional seeps and springs that were not flowing at the time of the initial survey due to seasonal variability. Id.

Because the conclusions in the Application are based on information that is inaccurate or unavailable and because the Director relies on that information to conclude that seeps and springs in the area of the mine would not be impacted by contaminants from the mine, the Director's decision violates R317-6-6.4(A). TomCo, and by extension the Director, has failed to demonstrate that ground water quality protection standards will be met or that present and future beneficial uses of the ground water will not be impaired. Because the company failed to accurately describe the hydrology of the mine site as that relates to area seeps and *springs that could be impacted by the mine as required in R317-6-6.3(E) & (K) and R317-6-6.4, the Director's approval of this permit is arbitrary, capricious and a violation of the law.*

6.4 DWQ Response

The requirements of Rule 317-6-6.3(E) and (K) were presented in Section 9 of the ground water discharge permit application. The Statement of Basis summarizes how DEQ came to issue the permit under Rule 317-6-6.4 (A)

As shown by the topography illustrated by contour lines on Figure 9-1 of the ground water discharge permit application, the drainage containing S1, S2, and S3 flows from the northeast. The mine site is located to the west and is separated from the seeps and springs by East Seep Canyon. These facts eliminate the potential for surface flow from activities on the mine site to impact the seeps or springs.

Based on depth to water measurements in each of the 3 intermediate depth monitoring wells, occurrences of perched ground water within the vadose zone are a minimum of 191 feet below the springs located east of the mine site (refer to Figure 9-1 of the ground water discharge application) and depth to the aquifer in the Douglas Creek Member as measured in the deep monitoring well is over 500 feet below the springs. As a result DWQ is convinced the springs are not down gradient of the mine.

Permit Action: None

Comment 7 (7.1)

The Permit Fails to Demonstrate that the Discharge Can be Properly Controlled.

The permit does not require complete and accurate information to establish that the discharge can be controlled as required by R317-6-6.3(G) and R317-6-6.4. While the company claims that the mine operation will be a zero-discharge operation, Application at 98, that claim is based on unproven and untested technology. Therefore, there is no basis for the Director to conclude that it is unlikely that the capsule would cause a discharge of contaminants to the subsurface. See Statement of Basis (SOB) at 8.

7.1 DWQ Response

TomCo's ground water discharge permit application may have represented the capsule design as a "zero discharge" facility but the permit is not based on a zero-discharge design for the EPS capsule. See Statement of Basis § 5. Rather, site conditions and what is known about the nature of the potential discharge justify considering the proposed design for the EPS capsule to be Best Available Technology as applied. The permeability of the underlying bedrock is so low[38] that discharge from an unlined, uncapped pile of spent shale would not seep through and impair the Douglas Creek Aquifer, even if some seepage were to occur.

Taking into account the unknown factors of the new technology and the design of the system, given the conditions of the site, DWQ is satisfied that this permit approval is very conservative. The most important factors regarding protection of ground water in this case are the nature of the facility and the site conditions. The capsule contents will always be under unsaturated conditions and significant amounts of water will not collect and build up on the lower BAS liner. If some small flux of leachate does bypass the metal collection pan and migrate through the lower BAS liner, the geologic strata underlying the capsule have very low permeability. The first aquifer underlying the site is hundreds of feet below ground surface and is under confined conditions with an upward hydraulic gradient.

Comment 7 cont. (7.2)

Further, in spite of the Director's request that the company conduct SPLP testing on spent shale from TomCo's project area, the company instead went to great lengths to argue that the tests conducted by Red Leaf from its spent shale were sufficient to address the Director's concerns. As Mr. Lips points out in his report, there are several problems with TomCo's assertions that the Director has chosen to ignore. First, while TomCo insists that the thickness of the Mahogany Zone at its mine site is similar to that found at the Red Leaf site, the company offers no references or data supporting the contention that thickness in the beds at these two sites relates in any way to leachable contaminants in spent oil shale. Lips at 9-10; see also Application at 100.

Second, the company provides no references or data supporting its assertion that the similarity of the Fischer analyses means that a similar lithologic rock type containing similar amounts of hydrocarbon and sharing a common geologic origin will yield similar SPLP results. Lips at 10; see also Application at 100. To the contrary, Mr. Lips notes that the data indicated that the geology is not uniform across the basin and that TomCo fails to consider the possibility that there is some physical, chemical and/or geologic explanation for the variability in the oil yield between the Red Leaf and TomCo sites. Lips at 10.

Third, while TomCo asserts that there is a similarity in the lithology of the zone to be mined at the two sites, the data indicates that there is a great variability in the lithology of the Mahogany Zone. Id. Fourth, TomCo did not base the comparison of the lithologies on quantitative properties of the rocks that directly relate to their leaching properties. Id. Without this data, there is no basis to support assumptions about the leaching potential of the TomCo oil shale. Id. Finally, TomCo was perfectly capable of conducting the SPLP tests based on bench testing material from its site, and the Director offers no reasonable explanation why he chose not to enforce his request that the company provide such information.

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[38] Price and Miller, pg. 10 table 1

Because the Director does not require complete and accurate information to show that the discharge can be controlled and will comply with the appropriate ground water quality standards as required by R317-6-6.3(G) and R317-6-6.4 and instead has accepted TomCo's assertion that the Red Leaf SPLP tests serve as an acceptable substitute for conducting those tests on oil shale from TomCo's mine site, the Director's decision is arbitrary, capricious and a violation of the law.

7.2 DWQ Response

Given that the TomCo and Red Leaf sites are located approximately 12 miles apart and share the same geologic origin, it is unlikely SPLP results from spent shale collected at each site will yield significant differences. Nevertheless, Part II.F.2 of the permit requires TomCo to collect representative samples of spent shale from the site within 2 years of cessation of capsule heating. Should these samples provide unexpected results, design changes can be required as appropriate in the reclamation plan required by DWQ under Part II.F.4 of the permit.

It should be noted that the current cover design specifies a BAS cap, or functionally equivalent design, that has a permeability of 1×10^{-7} cm/sec. This requirement will minimize the infiltration of precipitation into the spent shale pile (and generation of leachate), regardless of the leachability of the spent shale samples. So, the SPLP data, although good information to have, will likely not affect the already conservative capsule cover design.

Permit Action: None

Comment 8 (8.1)

The Permit Fails to Require TomCo to Monitor Ground Water in the Area of the Mine.

Given that the EPS capsule has never been constructed, there is no basis in the record for the Director to conclude "that construction of the EPS capsule as presented in TomCo's ground water discharge application will not degrade beneficial uses of ground water." SOB at 7. This is especially true given the admission in the previous sentence that "[t]he issuance of this permit is part of an evaluation phase that will be used to test assumptions and factors related to ground water protection, capsule performance and site conditions that are still not completely known." Id. Apparently, the Director assumes, without basis in the record, that the BAS liner will remain intact after being subjected to extreme heat over an extended period of time. As outlined in detail above, there is no justification for this contention. Further, the Director is also unjustified in his conjecture that there is an "unlikely possibility that the capsule would cause a discharge of contaminants to the subsurface," as a basis for concluding that monitoring ground water "would not provide useful information to evaluate TomCo's compliance with the Ground Water Quality Protection Regulations." SOB at 8.

Because the Application does not contain complete and accurate information *demonstrating that any discharge can be contained and will not migrate into or adversely affect the quality of waters of the state, as required by R3 I 7-6-6.3(G) and R317-6-6.4, the Director must require the company to conduct monitoring to determine the impact of the capsule on ground water resources using monitoring wells that the company has already installed. Further, the Director must require the company to install additional monitor wells across the mine site sufficient to collect data necessary to describe hydrologic conditions including ground water flow direction, ground water quality, aquifer material, saturated thickness, porosity, hydrologic connectivity and flow system characteristics of the aquifers. Lips at 11. Water quality monitoring in these wells should be used to establish baseline conditions and monitoring should continue as a permit condition. Id.*

Further, because the company has not attempted to explain the significance of these springs and whether they will be impacted, the Director must also require TomCo to monitor the springs previously identified by the company as well as any additional springs identified in subsequent seasonal seep and springs surveys. Lips at 11. Further, the Director must require the company to include in the Application a description of all compliance monitoring points. These compliance monitoring points should be established and data collected to determine baseline conditions before TomCo constructs the EPS or otherwise conducts any mining operations. Id. The Director should also require TomCo to provide a description of: 1) the installation, use and maintenance of the monitoring devices; 2) monitoring of the vadose zone; 3) measures to prevent ground water contamination following cessation of operations, including post-operational monitoring; 4) a description and justification of parameters to be monitored; and, 5) quality assurance and control provisions for the monitoring data. Id. Because he has not required this crucial monitoring, reporting and information gathering, the Director's decision is arbitrary, capricious and in violation of the law.

8.1. DWQ Response

The EPS capsule site is not underlain by "aquifers" at shallow depth as described previously in response to comment 1.1. Also refer to comment response 1.1 for a discussion of why monitoring wells are not the most effective monitoring points for detecting a release of contaminants from the EPS capsule. Monitoring wells installed in isolated, discontinuous, lenses of sandstone that contain limited quantities of water and are surrounded by low permeability shale layers have a low probability of detecting a release from the EPS capsule. Lacking an interconnected ground water flow system beneath the site, installing a monitoring well network to monitor for discharges from the EPS capsule would be ineffectual.

As described in comment response 6.4, the springs are topographically separated from the mine site and hydrologically up-gradient, therefore cannot be impacted by contaminant discharges from the capsule.

The permit requires source monitoring of any leachate that may collect on the metal collection pan within the capsule, the upper surface of the lower BAS liner, and between the bedrock foundation and the floor of the capsule. This would detect any problems with leachate discharge long before there would be a discharge to the subsurface. The rocks underlying the capsule are of very low permeability.

Permit Action: None

Comment 9 (9.1)

The Permit Does Not Contain a Closure and Post-Closure Management Plan as Required by R317-6-6.3(S).

The Director has failed to require a Closure and Post-Closure Management Plan as part of the GWDP as required by the Ground Water Quality Protection regulations. See R317-6-6.3(S) and R317-6-6.4. Therefore, there are no provisions for operational shut-down and subsequent drain-down and handling of petroleum containing liquids. Such a management plan is especially important in the case of an unplanned mine closure. Kuipers at 6. Various state and federal agencies require that an interim or emergency fluid management plan be part of reclamation and closure plans at mines. Id. If TomCo were to abandon the site during operations, it is likely that the State of Utah would have to dispose of significant quantities of process solutions containing deleterious materials. Id. Because there is no mention of a closure or post-closure plan in either the Application or the GWDP, the Director's failure to address this deficiency was arbitrary and capricious and a violation of the law.

9.1 DWQ Response

The requirements of Rule 317-6-6.3 have been met. As discussed in the Introduction, Rule 317-6-6.3 lists all informational categories that may be used within the universe of permitted facilities to provide substantial evidence in the administrative record to support a finding that Rule 317-6-6.4.A has been satisfied. However, Rule 317-6-6.3 also gives the DWQ discretion to determine the level of information it needs to make this finding.

To insure adequate reclamation, as DWQ's familiarity of the Eco-Shale capsule technology grows with the experience of EPS capsule operation and closure, Part II.F.4 of the permit requires TomCo to develop a reclamation plan that is protective of ground water quality following the investigations into leachate chemistry and capsule performance required in Parts II.F.2 and II.F.3 of the permit.

Moreover, there is a double layer of regulatory protection in that TomCo is also required to complete site reclamation by the Division of Oil, Gas and Mining (DOGM), and a bond will be collected by that agency prior to commencing activities to insure site reclamation in case of an unplanned mine closure.[39]

[39] Notice of Intention to Conduct Large Mining Operations Holliday Block Mine M\047\0120 approved by the Division of Oil, Gas, and Mining February 4, 2015.

It should be noted that operation of the EPS capsule will not involve process solutions so a requirement for emergency fluid management as proposed by the comment is unnecessary. Permit conditions in Part II.D require TomCo to remove from the site all liquid hydrocarbons for as long as they drain from the capsule. In the event of an unplanned abandonment of the site, liquid hydrocarbons would return to solid state as the capsule cools. The DWQ is satisfied given expected capsule performance, spent shale leachate characteristics, site characteristics, and permit requirements, that ground water contamination will be adequately prevented during closure and post closure phases. In the event of an emergency shut down or abandonment, the reclamation required by DOGM is adequate to close the site in a manner that is protective of ground water.

III

Comment Exhibit List

DWQ Exhibit List Response

The WRA exhibit list identifies 5 exhibits. Three of those are from a permitting action that is or was before the Board and Division of Oil, Gas and Mining (DOGM). For instance, Exhibit C is the Notice of Intention to Commence Large Mining Operations (NOI). Exhibit D is a protest of DOGM's tentative decision to approve the NOI. Exhibit E is the protest exhibits A-M. Neither WRA, nor Kuipers nor Lips identify the relevance of and the relevant portions of these materials. Therefore, DWQ has not reviewed or evaluated these exhibits in the context of responding to WRA's comments, except as specifically noted herein. In addition, DWQ received a letter dated January 30, 2015 from TomCo's counsel indicating that Living Rivers, TomCo and DOGM stipulated to the dismissal of Living Rivers' protest before DOGM so that Exhibits C, D (and Exhibits A through M attached thereto)(Exhibit E) should be removed from the comments filed by Living Rivers regarding Ground Water Discharge Permit No. UGW470003. DWQ takes judicial notice of DOGM's final NOI where cited herein.

Permit Action: None

DWQ RESPONSES TO REPORTS ATTACHED AS EXHIBITS TO WRA'S COMMENTS
Excerpts from the reports are restated verbatim in italics.

DWQ Responses to Excerpts from Kuipers Report, Exhibit A to WRA's Comments

Kuipers 1 (Heap Leach)

TomCo has licensed Red Leafs EcoshaleTM In-Capsule Technology (hereinafter referenced as "capsule") approach (Application, p. 2) for its project. This is a proposed and as yet unproven method for the extraction of kerogen from oil shale. The capsule method, compared to conventional processing of oil shale from retorting processes, in some respects is comparable to ***heap leaching*** *for gold or copper versus traditionally more energy intensive milling processes. Similar to the less expensive heap leach process, the capsule approach would utilize run-of-mine sized material placed in a Bentonite Amended Soil (BAS) lined facility (NOI, Appendix A, p. 1) rather than more intensive milling and retorting processes employed in the past and at present in oil shale producing regions such as Estonia. The oil shale capsule approach would then seal the pile and apply heat in order for the pile to act as a retort and mobilize the contained petroleum. Commercial-scale capsules would be located within mined areas and according to TomCo could be reclaimed by standard techniques following cooling and settling of the capsules.* [Kuipers at p.3, emphasis added.]

*   *   *

all of which have been shown to be highly important in ***heap leach*** *and other designs that rely upon similar containment systems.* [Kuipers at p.4, emphasis added.]

*   *   *

No provisions for operational shut-down and subsequent drain-down and handling of petroleum containing liquids are contained in reclamation information provided in the Application. This is especially important in the case of an unplanned mine closure. The inclusion of interim fluid management, also referred to as emergency fluid management, is an integral reclamation and closure task common to mine sites recognized by the Office of Surface Mining, Bureau of Land Management, Forest Service and states such as Nevada and Montana. The typical tasks required include management of process solutions upon operator bankruptcy resulting in the abandonment of the site to prevent discharge of those solutions, and involves the cost of manpower, equipment and materials involved in the management of those materials for a minimum of six months and in some cases three years or more.

In the event Tom Co were to abandon the site during operations it is likely that the State of Utah would have to manage significant quantities of in-process solutions as well as immediate draindown solutions from the capsules. It is also likely that the State would eventually have to dispose of significant quantities of process solutions containing pollutants. Both of these tasks could result in significant cost to Utah taxpayers if the interim water management and fluid draindown tasks are not addressed in a reclamation and closure plan. [Kuipers at p.6.]

DWQ Response to Kuipers 1 *(Heap Leach)*

If the TomCo operation were similar to a heap leach operation, DWQ would share Mr. Kuipers' concerns. DWQ is satisfied that the ground water discharge permit application and other documents in the record demonstrate that it is not, and that such concerns do not apply in this case (Table 1).

Table 1: Operational Comparison of The EcoShale^{TM} EPS process versus Conventional Gold or Copper Heap Leach.

	TomCo Operation	**Au or Cu Heap Leach Operation**
Water used in the extraction process, i.e. "process water"	NO	YES
Process Water Ponds needed for Operation, e.g. solution ponds	NO	YES
Any chemicals or additional extractive agents added (which of course themselves could present a contamination concern)	NO	YES
Pregnant Leach Solution (PLS) collection ponds required	NO	YES
Draindown of ore required after operation ceases due to water used in the process	NO	YES
Enhancement of potential contaminant mobilization or migration due to use of water or additional extractive agents	NO	YES
Potential for hydraulic head (contaminant migration driving force) to develop while in operation	NO	YES
Is the ore from which extraction takes place partially saturated before or after operation	NO and NO	NO and YES
Need for double lined ponds with leak detection	NO	YES
Need for any liner beneath or around the extraction ore	NO	YES

Kuipers 2 (Capsule Stability)

The stability analysis submitted by TomCo as Appendix F to its NOI was performed for Red Leaf by Norwest and consisted of a "preliminary analysis" (Norwest, 2011, p. 1).[1] *Materials that have been reviewed do not contain the level of site-specific technical analysis* *which should be required of the project proponent, particularly given that the analysis was performed using data from the Red Leaf site. A preliminary analysis uses professional judgment rather than site- specific data and generally relies upon the project proponent to conduct detailed final analysis using site-specific data to verify the results of preliminary analysis. In this case, the analysis submitted by TomCo focuses exclusively on the Red Leaf project and does not address the site- specific data applicable to TomCo's location. Similarly, model parameters used were assumed and based on experience with similar materials and literature review (Norwest, 2011 a, p. 2) rather than site-specific materials information which would provide much more reliable data. It is not uncommon for plans to require significant changes to the foundation and containment designs over successive design generations to account for site-specific conditions when they are based on preliminary analysis. This is certainly true in this case given the expected changes to the design resulting from the EPS testing. In order to provide for confident data and analysis, the geotechnical evaluation should have relied on borings and materials analysis from a variety of samples taken from the site and representative of the actual site conditions.*

The BAS and insulating gravel units were not included in the preliminary backing wall stability analysis (Norwest, 2011a, p. 2) and should be considered in a more detailed analysis using site- specific data. The BAS and insulating gravel units represent potential weak layers in the design. According to the proponent's consultant, the intact strength of the bedrock foundation and risk of planar bedding failures through weak layers would affect the stability of the backing walls and impact the integrity of the BAS liner and should be further investigated and include lab testing of actual site materials (Norwest, 2011a, p. 4). Planar failures result when a discontinuity dips out of a slope surface such as that of the BAS and insulating gravel layer. For this reason, the information in the Application should have contained additional investigations related to the site- specific materials to be used in creating the BAS and insulating gravel units and their properties and the BAS and insulating gravel units should have been included in the stability analysis.

The stability of the backing walls and the integrity of the BAS liner will be adversely affected by the heat and pressure generated within the capsules during the retorting process and should be evaluated during the EPS testing (Norwest, 2011a, p. 4). While no comparable design has been methodically tested for performance under similar conditions, other cover systems such as geomembrane liners and composite liners using soil and geomembrane systems have been shown to be highly susceptible to conditions such as heat resulting in significant degradation of liner integrity over time.[2] *Liner integrity would similarly likely be affected by other conditions such as the pressure and associated solution contact in the form of retort steam and liquid products. Wetting and drying of BAS liners can result in material shrinkage and desiccation. Potential chemical alteration by mechanisms such as ion exchange could degrade the liner and compromise the integrity of the BAS. If the BAS materials are compromised by any of these processes, the stability of the capsules as well as the integrity of the liner system to prevent discharge would be adversely affected and it is highly likely that this would result in a release of pollutants.*

While the company is appropriately proposing to construct a prototype EPS at a significant scale, it is not proposing to excavate into the decommissioned EPS capsule in order to examine the impacts that the heating process will have on the BAS materials and on such critical components as the metal sheet that the company plans to use to collect fluids. Without such excavation and examination of the potential degradation of the buffer and liner system and examination of its integrity relative to the EPS test conditions, there is no way for the company or regulatory agencies to properly evaluate the results of the testing process.

<u>DWQ Response to Kuipers 2 (Capsule Stability):</u>

Please refer to the response to comment II(3.1) presented previously for an explanation of why excavation of the capsule is not necessary to evaluate capsule stability. Ground water is protected by site conditions, and Part II.F.3 of the permit requires TomCo to evaluate the integrity of the upper BAS liner following retorting and cooling of the EPS capsule.

<u>Kuipers 3 (Process Solution and Post-Retort Draindown and Leachate Collection)</u>

A steel plate referred to as an "oil collection pan" is placed on top of the insulation layer near the bottom of the capsule (Application, p. 16). However, no information is presented to the public as to the viability of the metal liner design and collection pipe system or quality assurance/quality control measures to ensure their proper installation, all of which have been shown to be highly important in heap leach and other designs that rely upon similar containment systems. The metal sheet pan collection approach is novel to the proposed capsule process and, outside of Red Leafs proposal, has not been used elsewhere to my knowledge. It is highly likely that the metal sheet will be affected by the heating and pressurization process as well as the weight and settling of the material and will cause warping and weld failures in the metal sheet which will result in the sheet allowing solution to pass through and in tum result in increased reliance on the BAS liner to accomplish capture and to prevent solution discharge.

According to the Bureau of Land Management (FPEIS p. 4-31 to 4-32)[3] common impacts from oil shale development include "Spent shale piles and mine tailings that might be sources of contamination for salts, metals, and hydrocarbons for both surface and groundwater" and (DPEIS p. 4-32) "Degradation of groundwater ...from contributions of residual hydrocarbons or chemicals from retorted zones after recovery operations have ceased; and, from spent shales replaced in either surface or underground mines." Based on this information the proponent has not adequately identified the spent shale as a potential source of pollutants and as a result has not emphasized the proper management of these materials either during operations, in the event of unanticipated closure, during the solution draindown period, or post reclamation. Given the high likelihood for capsule liner failure as previously *described, there is an equally high risk that any solution which escapes from the capsule will contain pollutants.*

The operation is proposed as a zero-discharge operation that will include primary and secondary containment (Application p. 34). However, other than the primary BAS system no additional secondary containment such as a drainage and capture network below the BAS has been proposed for the EPS. Given the potential likelihood of failure of the BAS, a true zero-discharge design would incorporate an additional redundant liner and leak detection system, such as a geomembrane liner overlain by a geogrid draining to a collection point. In addition, at least one if not more downgradient groundwater monitoring wells should be included in the EPS proposal as an additional measure of BAS system containment.

The proposal relies on "proprietary fabrications" to address BAS seal function (Application, p. 18). In a heated and pressurized retort environment this is problematic given the high likelihood of failure that liner seals have exhibited in other similar designs under less onerous conditions. Considerable effort has been required to successfully design and construct liner seals in heap leach processing and other applications which are relatively mundane in comparison to the requirements which will be placed on liner seals in a heated and pressurized retort environment. The liner seals proposed for the capsule design which consists of a pressurized and heated retort application represent a specific design area in this novel approach where there is a high likelihood of failure which would be likely to result in discharge of retort solutions containing pollutants.

Further, there is a significant potential for differential settling within the capsule which would occur over a longer term (e.g. years versus months) than is predicted. Differential settling would result in some areas of the pile settling more than others and is common in similar instances where large amounts of settling relative to the overall material height have been constructed. The EPS proposal will allow for evaluation of settling, however the time period over which it may occur could be in excess of five years and take place for potentially 25 years or more.

<u>DWQ Response to *Kuipers 3 (Process Solution and Post-Retort Drain-down and Leachate Collection)*</u>

The following is a summary of the EPS capsule system and the safety factors as evaluated by DWQ that have been engineered into that EPS system.

- ET Cover – The ET cover system will be sloped so that any significant rain fall or snow melt will runoff the cover. The precipitation that does not runoff will be taken out of the system through evaporation and transpiration (evapotranspiration).

- Upper BAS Layer – Water that could work its way through the ET cover would then encounter a minimum 3 foot layer of BAS with a permeability of $1x10^{-7}$ cm/sec. This layer is also sloped to carry water away from the EPS capsule. Post-cooling the EPS capsule will be evaluated for settlement, especially differential settlement and if necessary a new 3 foot layer of BAS will be installed as part of the cover system. The EPS capsule will also be drilled and cored to see how the heating may have impacted the BAS layer.

- Spent Shale Retort Material – The heating of the oil shale will initially drive off all the water and then liberate the petroleum liquids drying the oil shale even further. After the capsule is completely cooled any moisture entering the capsule would be drawn into this very dry spent shale and leaching of this material would only take place when the moisture level is above the field capacity of the spent shale. The spent shale will also be analyzed to see if moisture in the system would actually leach any contaminants. Post-cooling the drilling and coring will evaluate the moisture retention and contaminate leach ability of the spent shale.

- Lower BAS Layer – Moisture that would be released from the ore would then encounter the lower BAS layer that again has a permeability of $1x10^{-7}$ cm/sec. Again the post-cooling coring will evaluate the condition of the BAS layer.

- Shale Layers Underneath the EPS Capsule – There are hundreds of feet of low grade oil shale under the EPS capsule that act as an aquiclude.

As shown by the bulleted items above there are numerous safety factors built in to the design of the EPS capsule. And, as shown in Table 1 above, DWQ believes that the comparison to heap leaching has no merit or relevance to TomCo's operation and the conditions at this site. This is consistent with the fact that TomCo is not adding anything whatsoever to the shale, see Table 1 above and TomCo has demonstrated satisfactorily that an aquifer does not exist immediately beneath the mine and that potential for contamination at the site is negligible.

Kuipers 4 (Post-Closure Sampling)

According to the draft public notice version of the Statement of Basis, TomCo will be required to obtain representative samples of spent shale, including hydrocarbons, and analyzed by the SPLP and MWMP methods. In addition, testing by the TCLP method (EPA Method 13, Toxic Characteristic Leaching Procedure (TCLP) may also be appropriate. The TCLP method is used to determine if a waste is hazardous under RCRA. It is intended to simulate municipal landfill containing organic wastes. The TCLP is designed to determine the mobility of both organic and inorganic analytes present in liquid, solid, and multiphasic wastes.

Due to the undefined nature of the spent shale oil in terms of regulatory jurisdiction (e.g. RCRA applicability) we recommend that testing be performed on representative samples using SPLP, MWMP and TCLP methods. In addition it is important that separate samples representative of various areas and depths of the EPS be sampled and individually analyzed to determine variability within the EPS. A single representative sample of the EPS would not *be representative of the capacity of various parts of the pile to contain and leach significant contaminants.*

DWQ Response to Kuipers 4 (Post-Closure Sampling)

DWQ believes that the SPLP and MWMP are the appropriate tests. DWQ agrees that representative samples from within the EPS will require collection from various areas and depths and will require such under permit Part II.F.2 sampling requirements. TCLP analysis is not necessary for the reasons discussed in 9.2 DWQ Response above.

Kuipers 5 (Closure and Post Closure Management Plan)

No provisions for operational shut-down and subsequent drain-down and handling of petroleum containing liquids are contained in reclamation information provided in the Application. This is especially important in the case of an unplanned mine closure. The inclusion of interim fluid management, also referred to as emergency fluid management, is an integral reclamation and closure task common to mine sites recognized by the Office of Surface Mining, Bureau of Land Management, Forest Service and states such as Nevada and Montana. The typical tasks required include management of process solutions upon operator bankruptcy resulting in the abandonment of the site to prevent discharge of those solutions, and involves the cost of manpower, equipment and materials involved in the management of those materials for a minimum of six months and in some cases three years or more.

In the event Tom Co were to abandon the site during operations it is likely that the State of Utah would have to manage significant quantities of in-process solutions as well as immediate draindown solutions from the capsules. It is also likely that the State would eventually have to dispose of significant quantities of process solutions containing pollutants. Both of these tasks could result in significant cost to Utah taxpayers if the interim water management and fluid draindown tasks are not addressed in a reclamation and closure plan.

DWQ Response to Kuipers 5 (Closure and Post Closure Management Plan)

The DWQ has addressed this comment in 9.1 DWQ Response above.

Kuipers 6 (Conclusions)

Based on my review the following conclusions can be reached concerning the risks presented by the proposed capsule technology: (1) The new technology has only been demonstrated at a pilot scale and is technically and economically unproven as a commercially viable technology; (2) Beyond Red Leafs proposed construction of an EPS capsule, research has not shown any similar proposed approach to oil shale production or production of other commodities using a similar approach from either a retort, as well as general contaminant containment design under those conditions, making the proposed project unique and *therefore highly subject to original design deficiencies and economic failure; (3) Given the history of similar endeavors in the mining and oil/gas industry it is highly likely that the project will prove to be uneconomic and could cease operations within 2-3 years of start-up or otherwise during the expected course of operations; (4) Given similar technological developments it is likely that initial efforts to capture and contain liquid petroleum containing products will not be successful as it is highly likely that unexpected forces will be exerted in terms of liquid head or saturation within the pile resulting in the additional potential for loss of liquid products containing pollutants outside the capsule, and; (5) The degree to which the retorting process might result in deformation or reaction with the capsule materials as well as the resulting settling of the pile makes long-term effectiveness of the containment questionable and short-term reclamation of the surface of the capsule difficult due to highly uneven surfaces requiring significant regrading to accomplish positive drainage off the top surface of the reclaimed capsules.*

The capsule proposal is without precedence from an engineering standpoint and therefore has inherent risks. It is not known how a three-foot thick bentonite liner will perform under the proposed conditions. We know how a six or twelve inch liner used for heap leaching or municipal waste disposal (e.g. landfill) might behave under much less rigorous conditions and know that failures are typically very site or incident specific. This means reliance on preliminary analysis rather than site-specific data is likely to lead to underestimation of failures, and that processes which exert more demands, such as those involving heat and pressure, would be more likely to result in failures. How a three-foot thick liner used in retort conditions with heat and pressure might behave in terms of fluid containment over the short or long-term, is as much dependent on the oil and gas retorting process, which is also novel in this case, as it is on the novel liner itself in this specific application.

My best professional judgment is that because this is a novel concept involving significant chemical and physical demands upon the proposed BAS containment system there is a high likelihood there will be significant failures resulting in release of deleterious materials. And while construction of the Early Production System could answer many of those questions, the company does not propose to take the necessary step of doing post-decommissioning excavation of the capsule and require installation and monitoring of a secondary leachate collection system in order to allow for direct examination which is necessary to determine how the BAS liner has performed. Without this essential step, there is no assurance that the BAS liner integrity, metal sheet design, seal designs, and post-operation settlement of the EPS will perform to similar expectations in a commercial application. Finally, site-specific geotechnical data should be gathered and used to evaluate stability and other aspects of the proposed design.

<u>DWQ Response to Kuipers 6 (Conclusions)</u>

The conclusions are irrelevant due to site conditions or are unfounded due to an erroneous comparison of TomCo's operation to a heap leach facility; see Table 1 above, sections I.D and E and response to comments (Kuipers 1-5 above) and others.

DWQ Responses to Excerpts from Lips Report, Exhibit B to WRA's Comments

Lips 1 (Incomplete and Inaccurate Description of Geology and Hydrology)

The Utah Ground Water Quality Protection Rules require that an application for a ground water discharge permit contain geologic and hydrologic descriptions including aquifers, ground water flow direction, ground water quality, aquifer material, and well logs (R317-6-6.3 (E)). In addition the rules require a description of the ground water most likely to be affected by the discharge, including water quality information of the receiving ground water prior to discharge, a description of the aquifer in which the ground water occurs, the depth to the ground water, the saturated thickness, flow direction, porosity, and flow systems characteristics (R317-6-6.3 (K)). TomCo's Application does not contain this information. The Application documents the presence of ground water in wells and nearby springs; however, the information in the Application fails to provide complete and accurate descriptions required by the Ground Water Protection Rules.

DWQ Response to Lips 1

This information was provided as described in the response to comment 1.1 and comment 1.3 presented previously.

Lips 2 (Incomplete and Inaccurate Description of Ground Water Beneath the Project Area

Ground water in the lower portions of the Parachute Creek Member (beneath the Mahogany Zone) are the aquifers immediately below the mine site and would be the first to be impacted by the mining and retorted operations.

In 2010, TomCo drilled nine core holes across the project area to determine the thickness and depth of the Mahogany Zone (Application, pg. 42). Several sandstone layers (potential aquifers) were identified in these core holes (Application, pg. 57), and TomCo notes that three of the core holes had "shows" of ground water suggesting that they could contain limited water bearing zones (Application, pg. 42}. TomCo further noted that a spring on the eastern portion of the site might have resulted from a sandstone layer or from secondary porosity that originated in fractured bedrock, and observed sandstone beds below the Mahogany Bed in outcrops west of the site (Application, pg. 43). These core hole and outcrop observations confirm that potential ground water-bearing layers are ubiquitous across the site. In addition TomCo notes that ground water may be stored in permeable sandstones beneath the Mahogany Zone (Application, pg. 43).

In 2013, TomCo drilled and completed three monitoring wells in the Parachute Creek Member below the Mahogany Zone, and one deeper monitoring well into the Douglas Creek Member (Application, pg. 45).

All three of the wells in the Parachute Creek Member encountered ground water that *refilled the wells after well completion (Application, pg. 55}. TomCo conducted testing of these wells in order to collect ground water samples and to assess the flow of water to the wells. MW-01 produced ground water at 0.48 gallons per minute (gpm); MW-02 produced ground water at 1.33 gpm; and MW-03 produced ground water at 0.87 gpm (Application pg. 53). Ground water from these wells has TDS of 5,700 mg/1, 1,100 mg/1, and 3,900 mg/1, respectively (Application, pg. 90). Based on these TDS values and other constituents, the ground water in these aquifers* *would be classified as Class II Drinking Water Quality Ground Water and Class Ill Limited Use Ground Water (R317-6-3.6).*

TomCo's three wells confirm the presence of aquifers in the Parachute Creek Member immediately beneath the Mahogany Zone. In fact, TomCo states that the overall hydraulic gradient for ground water in the Parachute Creek Member is 0.032 feet to the north or northwest (Application, pg. 64).

In October and November, 2014 TomCo conducted pump and recovery tests in the three monitor wells installed in the Parachute Creek Member in October 2013 (MW-01, MW-02, and MW-03). These test consisted of pumping water from the wells, and measuring the change in the water level during the pumping (drawdown), and the change in the water level in the wells once the pumping stopped (recovery) (Application, pg. 69). From these data, TomCo has estimated aquifer properties such as the transmissivity and hydraulic conductivity.

MW-01 had a static water column of 26.54 feet at the beginning of the test (Application, Appendix J, pg. 20). This well was pumped for 31 minutes at variable rates, with an average of 0.19 gpm over the entire pumping period (Application, pg. 74). After 7.9 days, the water level in the well had recovered to within 0.82 feet of the pre-pumping level, indicating nearly complete recovery of water back into the well (Application, Appendix J, pg. 2). Based on two methods of analysis with differing assumptions, TomCo estimates the transmissivity to be between $6x10^{-3}$ and 37 ft^2/day, and the hydraulic conductivity to be between $2x10^{-4}$ and 1.5 ft/day (Application, pg. 74).

MW-02 had a static water column of 18.45 feet at the beginning of the test (Application, Appendix J, pg. 7). This well was pumped for about 78 minutes at variable rates, with an average of 0.18 gpm over the entire pumping period (Application, pg. 77). After 8.1 days, the water level in the well had recovered to within 9.24 feet of the pre-pumping level (Application, Appendix J, pg. 2). Based on two methods of analysis and with differing assumptions, TomCo estimates the transmissivity to be between $1x10^{-1}$ and 2.6 ft^2/day, and the hydraulic conductivity to be between $7x10^{-4}$ and $2x10^{-1}$ ft/day (Application, pg. 78).

MW-03 had a static water column of 10.34 feet at the beginning of the test (Application, Appendix J, pg. 14). This well was pumped for 8.1 minutes at variable rates, with an average of 0.39 gpm over the entire pumping period (Application, pg. 81). After 8 days, the water level in the well had recovered to within 1.16 feet of the pre-pumping level, indicating nearly complete recovery of water back into the well (Application, Appendix J, pg. 2). Based on two methods of analysis with differing assumptions, TomCo estimates the transmissivity to be between $6x10^{-2}$ and 4.3 ft^2/day, and the hydraulic conductivity to be between $7x10^{-3}$ and 0.52 ft/day (Application, pg. 74).

TomCo's pump and recovery testing provides useful information on the aquifers in the Parachute Creek Member, immediately beneath the zone of planned mining.

1. *Each aquifer had a significant saturated thickness of the geologic materials (10.34 to 26.54 feet).*

2. *The geologic materials have sufficiently high permeabilities that they were able to sustain pumping of up to 0.39 gpm to the wells.*
3. *Two of the three wells showed recovery of water into the wells to nearly pre-pumping water levels in as little as about 8 days, again showing high permeabilities.*

4. *The transmissivities and hydraulic conductivities estimated by TomCo are in agreement with those of published values for other geologic materials capable of storing and transmitting usable quantities to wells or springs (silt, clayey sand, or silty sand; Application, pg. 86).*

However, TomCo's drilling, exploration and aquifer evaluation is incomplete and does not contain geologic and hydrologic descriptions for the entire site as required in R317-6-6.3 (E and K). The Application only provides limited data from three wells, and while these data confirm the presence of aquifers immediately beneath the zone to be mined with Class II and Class Ill ground water, TomCo fails to provide a site-wide description of the degree to which the aquifers are connected, the specific flow directions, flow system characteristics, or points of discharge. Simply put, three wells are insufficient for a 1,186-acre site. In addition, TomCo fails to evaluate the significance of secondary porosity, even though they acknowledge that the presence of bedrock fractures could provide a hydraulic connection between the Parachute Creek Member and the Douglas Creek Member (Application, pg. 44). Finally, the Application fails to evaluate any hydrologic connection between the aquifers in the Parachute Creek Member and the nearby seeps and springs.

DWQ Response to Lips 2:

The DWQ is satisfied that the monitoring well installation and pump testing summarized in the above comment demonstrate that there is not an aquifer present in the Parachute Creek Member below the mine site for the following reasons:

- six of the nine borings advanced into the Parachute Creek were dry;
- none of the three monitoring wells installed in the Parachute Creek Member were able to maintain sustainable pumping rates before going dry;
- volumes of water produced by each of the three monitoring wells before going dry ranged between 3.14 to 6.8 gallons; and
- water levels in the monitoring wells were monitored for approximately 8 days after pumping and none of the wells recovered to pre-pumping levels.

These occurrences of ground water do not represent an aquifer in any sense of the definition. Comment responses 1.1 and 5.1 above provide additional discussion on this topic.

<u>*Lips 3 (Incomplete and Inaccurate Description of Springs the Project Area)*</u>

TomCo conducted only a single field survey in October 2013 to identify seeps and springs in the project area and a 0.5-mile buffer (Application, pg. 92). Standard practice in the field of hydrogeologic investigations is to conduct a series of several field surveys during different seasons. This is necessary in order to obtain a complete and accurate understanding of the seasonal occurrence of seeps and springs. One field survey, conducted in the fall, provides extremely limited information and restricts the ability to understand the hydrogeologic flow systems. In fact, at Red Leaf Resources site, a second field survey conducted in the spring confirmed that several of the seeps identified in the previous fall had significant flow.

In spite of this limitation, TomCo did confirm that, even in the fall when the discharge from seeps and springs are typically their lowest in Utah, numerous seeps and springs are present within, and surrounding the project site. TomCo documented 2 springs and 12 seeps during their field survey (Application, pg. 93). Eight of these seeps and springs had sufficient flow that TomCo was able to obtain samples for water quality analysis. While the Application does not report the full analytical results of these analyses, the TDS values for all seeps and springs vary between 750 mg/1 and 1,790 mg/1, which would classify these ground water sources as Class II Drinking Water Quality Drinking Water (R317-6-3.5).

The field survey failed to document the geologic occurrence of the seeps and springs. However, TomCo did note that almost all of the seeps and springs appeared to originate in or near drainage channels and at points where shale layers were exposed (Application, pg. 93). This is an expected occurrence where shale layers underlie sandstone layers and the vertical movement *of ground water is slowed. This observation suggests that these seeps and springs are locations of discharge from the aquifers present in the Parachute Creek Member that TomCo confirmed through their limited drilling program (TDS in MW-02 is 1,100 mg/1). Regardless of this limited information, the Application does not contain any geologic and hydrologic descriptions of the aquifers from which these seeps and springs emit, or the ground water flow direction and aquifer materials. The question left unanswered by the Application is what constitutes the source of the water that feeds the seeps and springs noted in the October 2013 inventory. Specifically, the question of whether those springs could be impacted by the mine must be answered.*

TomCo claims that Springs S1 and S3 are located upgradient of, and approximately 80 feet higher than the highest mine excavation planned, and that the springs recharge area is the slopes upgradient and northeast of the springs. Based on these assumptions, TomCo states that it is unlikely that either of the springs would be affected by mining or processing activities (Application, pg. 93). However, data in the Application directly refute some of these statements, and other statements are made with no supporting data and analyses.

First, Figure 9.1 of the Application shows the water elevation of Springs S1 and S3 as 6,253 feet and 6,283 feet, respectively. Figure 5-1 shows the proposed layout of the pit in the *southeast corner of the permit area. According to this figure, the highest elevation of the excavation will be about 6,470 feet, and the final pit floor will be between 6,330 and 6,270. This means that the springs are located about 187 to 217 feet LOWER than the highest mine excavation planned, and about not 80 feet higher, as claimed by TomCo. Furthermore, the elevation of the springs is within a few tens of feet of the pit floor elevation. Mining and removal of the overburden and Mahogany Bed will intercept any ground water that now flows through this area.*

Second, TomCo claims that the springs are located up gradient of the planned excavation and that their recharge area is towards the northeast. However, the Application provides no data to support this assumption. Specifically, there are no reported ground water investigations with measured ground water elevations from which gradients could be determined in this area. In fact, data elsewhere in the Application refutes this assumption.

The Application states that regionally, the direction of ground water movement is toward the north (Application, pg. 60) and the overall hydraulic gradient for ground water in the Parachute Creek Member is 0.032 feet to the north or northwest (Application, pg. 64). This is consistent with the assumption that ground water flow directions would generally follow the dip of the beds, which is towards the north (see Figure 9-4a, a north-south cross section near TomCo's eastern boundary).

In the fall of 2013, at a time when ground discharge is likely the lowest, Spring S1 had a measured flow rate of 3.3 gpm and Spring S2 had an estimated flow rate of 0.5 gpm (Application, pg. 94). The TDS of the water from the springs was 750 mg/1 and 752 mg/1 (Application, pg. 94).

Springs S1 and S3 are located about 1,500 to 2,000 feet from the planned excavation of the overburden and Mahogany Bed (Figures, 5-1, 9-1, and 9-4a). These springs have significant flow of Class II drinking water quality ground water. They are located 187 to 217 feet below the highest mine excavation planned, and within a few tens of feet of the final pit floor elevation. Based on the limited information in the Application, the springs are located down gradient of the planned excavation.

Furthermore, the Application fails to evaluate the potential impacts to Seeps S10, S11, and S 12 which are located very near, or under, the construction of the proposed mining facilities on the western side of the permit area (Application, Figures 5-1 and 9-1).

Given the importance of the seeps and springs within and near the permit boundary, and their potential of being impacted by the mining activities, it is imperative that additional investigations be conducted to more fully understand the aquifers in which the ground water occurs, the saturated thickness, flow direction, porosity, hydrologic conductivity, and flow system characteristics as required by R317-6-6.3 (K). As part of these investigations, it is essential that TomCo conduct additional seep and spring inventories, especially during the *spring months, in order to: 1) understand seasonal variability in ground water flow, 2) asses flow at the 12 "seeps" identified in the October, 2013 inventory, and 3) identify additional seeps and springs that were not flowing at the time of the initial survey. Only when these data are collected and analyzed will it be possible to assess potential impacts from the mining operations.*

<u>DWQ Response to Lips 3</u>

As noted in the ground water discharge application (p.93), most of the seeps identified during the survey appeared to be ephemeral in nature, with occurrences closely linked to recent rainfalls. The observation that almost all of the seeps and springs originate near drainage channels or at points where shale layers were exposed suggests these water sources are expressions of surface water run-off and infiltration of precipitation flowing laterally along the impermeable shale layer until it seeps out at the drainage channel exposure. Surface expression of a shallow aquifer would be perennial (stream, lake, etc.), representative of a permanent ground water flow system. Responses to comments 6.1 through 6.5 presented above provide further information on this topic and describe why the mine site activities are not a threat to the off-site springs.

<u>*Lips 4 (Failure to Demonstrate That Discharge Can be Controlled)*</u>

TomCo proposes to use Red Leaf Resources EcoShale In-Capsule Technology for their Early Production System (EPS) capsule (Application, pg. xvi). The Application's performance assumption are identical to those contained in Red Leafs application for their EPS capsule. Based on this information alone, TomCo assumes that their operation- specifically the EPS capsule will be a zero-discharge operation (Application, pg. 98). The sole demonstration that discharge can be controlled is based on this assumption. It is critical to note that Red Leafs operation has not been demonstrated to be a zero-discharge operation, and thus, TomCo's Application is based on an assumption regarding an untested new technology.

In my professional opinion, the performance of the capsule is one of the most critical issues regarding protection of ground water from the proposed TomCo operations. It is imperative that the Application provides a thorough and accurate evaluation of the potential for leachate to be discharged from the capsule. As it stands, the Application does not contain complete and accurate information that shows that the discharge can be controlled and will not migrate into or adversely affect the quality of waters of the state as required under R317-6-6.3(G).

TomCo assumes that the capsule design will result in a zero discharge. However, as discussed above, neither TomCo nor Red Leaf has demonstrated this to be the case. Apparently DWQ recognizes this shortcoming and therefore asked TomCo to conduct SPLP tests on spent shale from TomCo's project area to determine if leachable contaminants are present in the spent oil shale (Application, pg. 98). TomCo did not do these leaching tests as *requested. Rather, TomCo attempts to demonstrate that their site is similar to Red Leafs, and therefore they are justified in using the results of Red Leafs SPLP tests as surrogates for the spent shale at the Holiday Block. TomCo uses two variables to compare the geology of the TomCo and Red Leaf sites, bedding thickness and Fischer assays. The problems with TomCo's assumptions and analyses are discussed below.*

1) *TomCo has evaluated the thickness of several beds in, and near, the Mahogany Zone in order to demonstrate the similarity of the geology between the TomCo site and the Red Leaf site (Application, pg. 100). However, TomCo provides no data or analysis, or references to published literature supporting the assumption that bedding thickness in any way relates to leachable contaminants in the spent oil shale. In fact, there is no reason to assume that the thickness of a particular geologic unit would provide any information on the leachate produced from spent oil shale. Thus, the comparison of the bedding thickness between the two sites provides no relevant information to the question of leachate characteristics.*

2) *TomCo states that the similarity of the Fischer analyses suggests that these data can be extrapolated to the spent shale characteristics based on the hypothesis that a similar lithologic rock type containing similar amounts of hydrocarbon and sharing a common geologic origin, should yield similar SPLP results (Application, pg. 100). Again, TomCo provides no data or analysis, or references to published literature supporting the assumption that Fischer assays are in any way related to leachable contaminants in the spent oil shale. In other words, just because the beds are of similar thickness, and the Fischer assays are of the same order of magnitude, there is no supporting data that these two different geologic materials would produce similar leaching results. Furthermore, examination of the isoresource maps for the geologic units that TomCo evaluated (Figures 11, 13, 15, and 17 in Appendix K) show tremendous variability in the Fischer assay results across the Uinta Basin. Note the areas of high oil yield in almost all beds near the TomCo site versus the Red Leaf site. These data indicate that the geology is not uniform across the basin and that there is some physical, chemical, and/or geologic explanation for the variability in the oil yield that TomCo fails to consider in their comparison of the two sites.*

3) *A fundamental assumption that TomCo makes is that the lithology of the zone to be mined (Mahogany Zone) is similar at the TomCo site and Red Leaf site, and therefore, the SPLP results from the Red Leaf site are representative of what the S PLP results would be at the TomCo site. TomCo describes the lithology of Mahogany Zone as: "oil shale" (Application, Figure 9-2); "beds of kerogen interbedded with marlstones and shale, and occasional stringers of siltstone" (Application, pg. 57); "primarily shales, siltstones, and marlstones" (Application, pg. 63); with a "number of sand lenses" (Application, pg. 65); shale, marlstone, oil shale, and shale (Appendix C). The important point is that at the TomCo site, there is great variability in the lithology of the Mahogany Zone, as illustrated in the various descriptions and shown on the logs of the boreholes.*

At the Red Leaf site, the lithology of the Mahogany Zone is simply described as: "oil shale" (RLR, pg. 16). There is no validity for assuming that the lithologies at the two sites are similar based on only these descriptions.

4) *TomCo could have, but did not, base the comparison of the lithologies at the TomCo site and the Red Leaf site on quantitative properties of the rocks that are directly related to their leaching potential. The ability of residual oil and contaminants to leach from the spent ore is largely a function of the grain size of the material, the sorting of the grains, the porosity, and the permeability. Each of these properties can be easily measured and quantified by standard laboratory tests. Without quantitative data on these sedimentary rock properties, there is no basis for comparison of the lithologies between the sites in order to support assumptions about the leaching potential.*

5) *TomCo provides no explanation for not conducting the SPLP analysis on samples from their site. At the Red Leaf site, samples for the SPLP tests were collected from spent shale derived from bench-scale testing (RLR, pg. 37; Application, pg. 100). The SPLP analysis for Red Leafs spent shale was conducted in October and November 2011 (RLR, Appendix J), a year and a half before Red Leaf submitted their ground water discharge permit application to DWQ.*

The question that remains unanswered is why didn't TomCo conduct bench-scale testing in order to get samples of spent shale from their site? As demonstrated at Red Leaf, it is possible to conduct bench-scale tests and perform the SPLP analysis on the spent shale well in advance of submitting the application.

A larger question that remains unanswered by either Red Leaf or TomCo is how representative are the SPLP results from the bench-scale testing to the leaching characteristics of the spent ore in the EPS capsule? TomCo's application does not discuss the uncertainty associated with this scaling factor.

In summary, TomCo's attempt to use the SPLP test results from the Red Leaf site is unjustified. There is no basis to assume that a relationship exists between bedding thickness or Fischer assay results and leachable contaminants in the spent oil shale. The Fischer assay results show that the TomCo and Red Leaf sites are located in drastically different parts of the Uinta Basin, suggesting that there are physical, chemical, and/or geologic differences between the sites. The general descriptions of the lithology at the TomCo site demonstrate a wide range of rock types with different physical properties. Red Leafs description of the lithology is incomplete, and therefore, there is no basis for comparison of the lithologies at the two sites. TomCo failed to quantify sedimentary properties of the rocks that are more likely to be related to the leaching potential of the spent oil shale. TomCo could have determined if leachable contaminants are present in spent oil shale at their project area, as requested by DWQ, by analyzing samples of spent shale collected from bench-scale testing.

DWQ Response to Lips 4:

Given that the TomCo and Red Leaf sites are located approximately 12 miles apart and share the same geologic origin, it is likely SPLP results from spent shale collected at each site will yield comparable results. Additionally, Part II.F.2 of the Permit requires TomCo to collect representative samples of spent shale from the site within 2 years of cessation of capsule heating. Those samples will be site-specific, collected from within the EPS capsule, and will eliminate any questions associated with bench scale testing. Should those samples provide unexpected results, design changes can be required as appropriate in the reclamation plan required by DWQ under Part II.F.4 of the permit.

It should be noted that the current cover design specifies a BAS cap, or functionally equivalent design, that has a permeability of 1 x 10^{-7} cm/sec. This requirement will minimize the infiltration of precipitation into the spent shale pile (and generation of leachate), regardless of the leachability of the spent shale samples. Therefore, the SPLP data will likely not affect the already conservative capsule cover design irrespective of the results.

Lips 5 (Need for Ground Water Monitoring)

Because the Application does not contain complete and accurate information showing that the discharge can be controlled and will not migrate into or adversely affect the quality of waters of the state, as required by R317-6-6.3(G), TomCo can and should conduct monitoring to determine the impact of the mine on ground water resources.

TomCo only proposes to monitor within the EPS capsule and from a drain system constructed between bedrock and the outside edge of the BAS on three sides (Application, pgs. 24-25). TomCo proposes no actual ground water monitoring from any new or existing wells, or from any seeps or springs.

DWQ Response to Lips 5:

Mr. Lips contention that ground water monitoring is necessary or that source monitoring is insufficient at the TomCo site is unsupported and without basis. The permit requires source monitoring of any leachate that may collect on the metal pan within the capsule, the upper surface of the lower BAS liner, and between the bedrock foundation and the floor of the capsule. This source monitoring will detect any problems with leachate discharge long before there is a discharge to ground water because of the very low permeability of the rocks underlying the capsule. Ground water monitoring is not the chosen monitoring method at this site because any potential discharge from the capsule would not necessarily report to a monitoring well. Also, the Douglas Creek Aquifer is many hundreds of feet below the mine site, overlain by impervious and uneconomic oil shale, and therefore naturally protected by site conditions. Therefore, requiring source monitoring but not ground water monitoring is rational.

Lips 6 (Need for a Sufficient Sampling and Analysis Plan)

TomCo identified Class II Drinking Water Quality Ground Water and Class Ill Limited Use Ground Water in aquifers in each and every well completed in the Parachute Member beneath the Mahogany Zone and Class II Drinking Water Quality Ground Water in eight seeps and springs. Unfortunately, TomCo did not drill and install a sufficient number of wells that would allow for sampling and analysis of the water quality across the site. TomCo should install additional monitor wells that collect data that describe hydrologic descriptions including ground water flow direction, ground water quality, aquifer material, the saturated thickness, porosity, hydrologic conductivity, and flow systems characteristics of the aquifers identified and additional aquifers. Water quality monitoring in these wells should be used to establish baseline conditions and monitoring should continue as a permit condition.

In addition, because TomCo identified twelve seeps/springs in the vicinity of the mine site but has not made any attempt to explain the significance of these springs, where the water is coming from, and whether they are likely to be impacted, TomCo should monitor these springs to determine whether they will be impacted by the mining operation.

The Application should contain a description of all compliance monitoring points, ground water monitoring to determine ground water flow direction and gradient, and the quality of ground water at the compliance points. These compliance monitoring points should be established and data collected before TomCo conducts any mining operations in order to establish background conditions. The Application should also contain a description of: 1) the installation, use and maintenance of monitoring devices; 2) monitoring of the vadose zone; 3) measures to prevent ground water contamination after the cessation of operation, including post- operational monitoring; 4) a description and justification of parameters to be monitored; and 5) quality assurance and control provisions for monitoring data.

DWQ Response to Lips 6:

There is no evidence of an aquifer present above the Douglas Creek Member where MW-04 was installed, exhibiting a water level over 700 feet below ground surface. Provisions from R317-6-6.3 that Mr. Lips' cites here as being necessary for this permit were intended for permitting cases where monitoring an aquifer underlying the permitted facility is the primary means of demonstrating that the conditions in Rule 317-6-6.4A are met. That is not the case for this permit, and the DWQ has discretion to omit these requirements.

The only identified springs are located offsite, up-gradient, and in a separate drainage from the mine property, thus are not at risk of being impacted by mine activities. The EPS capsule and any future capsules would be constructed on bedrock at the base of the Mahogany Zone in a mine pit. Any discharge from the capsules would be to bedrock of very low permeability at an elevation below the land surface, and in the case of the EPS capsule at least, such discharge would not affect water which may be locally or temporally present in surficial deposits.

Lips 7 (Need for Stringent Monitoring Requirements)

The Compliance Monitoring Plan is incomplete and insufficient to assess impacts from the proposed mining and retorting operation. The purpose of the monitoring and reporting should be to detect problems early and address them with prompt and appropriate actions. The Application fails to state how any of the data submitted will be analyzed in order to guide decisions as to whether or not to cease operations of the EPS. For example, if monitoring shows that a discharge of leachate is occurring, what will DWQ do?

DWQ Response to Lips 7:

Data submitted for compliance monitoring will not be used to guide decisions on ceasing operations of the EPS because leachate formation and compliance monitoring will only happen after the EPS capsule is shut down. In the unlikely event that the additional data collected as required by this permit reveal that leachate discharge may be a significant threat from the EPS, the results will allow DWQ and TomCo to consider other ways in which it may be managed such as by requiring a more impermeable design for the upper liner cap.

Lips 8 (Need for Effective Ground Water Protection and Monitoring of Capsule Performance)

The method of recovering hydrocarbons from oil shale described in the Application is a new concept that has never been demonstrated at the scale that TomCo (or Red Leaf) proposes. TomCo states that the EPS has been designed so that the functionality and effectiveness of its key components can be further evaluated and modified to maximize performance for the future use in full-scale operations (Application, pg. xvi). In other words, this is a test facility that does not incorporate proven technology and neither TomCo or DWQ knows if the capsule design, particularly the BAS, will contain leachate, and if not, what the impacts to ground water will be.

Given this uncertainty, along with the documented presence of ground water immediately beneath the proposed mine, and the numerous springs in the vicinity of the mine, it is imperative that this EPS capsule be constructed on a liner system that can effectively contain any leachate that does discharge. DWQ should only issue a permit for this EPS capsule if it is constructed on a liner system that consists of an HDPE (or equivalent) liner and a leak detection and leachate recovery system between the capsule and the HDPE liner. A liner system of this type will provide the best available technology for protecting waters of the state.

In addition, the presence of leachate with this type of liner system will be detected in a time period that will allow DWQ to make informed decisions before permitting the full-sale *operation. While monitoring of ground water in wells and in nearby springs is necessary, the time that might be required for leachate to reach these source may be long enough that DWQ would, if no contamination were detected, incorrectly assume that no leachate was being discharged. However, the response time for detecting discharge of leachate could be reduced to a few days or weeks with the use of a HDPE and leak detection and leachate recovery system.*

In my professional opinion, the uncertainty regarding this untested capsule design, and the documented presence of aquifers that are likely to be impacted, requires that the EPS capsule be constructed on a liner system that is both protective of waters of the state, and provides a reliable means of evaluating the performance of the capsule.

<u>DWQ Response to Lips 8</u>

DWQ is satisfied as to the absence of aquifers at shallow depths under the EPS capsule site. Under the permit conditions, TomCo will monitor drainage from the metal collection pan within the capsule and from the top of the lower BAS liner. The extremely low probability that leachate would bypass these collection points without being detected and migrate through three feet of liner with hydraulic conductivity of 1×10^{-7} cm/sec while under little or no hydraulic head does not justify requiring construction of a leak detection system as described in the comment.

Liners that are mainly intended for product containment provide added protection, but the permit is not based on a zero-discharge design for the EPS capsule which would be an excessive standard in this case. Site conditions and what is known about the nature of the potential discharge justify accepting the proposed design for the EPS capsule to be Best Available Technology. DWQ's approval of TomCo's design is conservative considering these conditions. The permeability of the underlying bedrock is so low that discharge from an unlined, uncapped pile of spent shale would not seep through and impair the Douglas Creek Aquifer, even if some seepage were to occur.